BlueAdapt

THE FINNISH BLUE ECONOMY

Definition and Economic Significance

Essi Heikkinen
University of Helsinki
Faculty of Agriculture and Forestry
Department of Economics and Management
Master's Thesis
January 2019

Faculty:	Department:	
Faculty of Agriculture and Forestry	Department of Economics and Management	
Author:		
Heikkinen Essi Henriikka		
Title:		
The Finnish Blue Economy – Definition and Economic Significance		
Subject:		
Environmental and Natural Resource Economics		
Level:	Month and Year:	Number of pages
Master's Thesis	March 2019	76

Abstract:

Marine ecosystems and oceans have a vital role in sustaining life on Earth. Additionally, the oceans have an essential role in the world's economy as the main platform for global trade as well as a provider of many raw materials and resources. Due to the degradation of these marine ecosystems, the wellbeing of the seas and oceans has risen to the forefront of many global and regional political initiatives and agendas, and consequently, new concepts such as the blue economy have evolved. However, the sector lacks a clear consensus regarding its definition.

In the absence of a unified definition, there is no general perception of what the blue economy sector means for the national economy of Finland. In order to efficiently and optimally regulate and manage the use of ocean resources and space, it is essential to understand the economic contribution and the role of industries linked to it. As a part of a more extensive research project called Blue Adapt, this thesis strives to identify the industries regarded as blue economy and measure their current economic contribution in Finland.

In order to estimate the economic size of the blue economy sector, first the definition of the concept is clarified. The definition as well as the identification of economic activities regarded as part of it, is made based on a literature review. In the literature review, different studies are compared and analyzed and as a result, the most common activities are selected.

The economic contribution of these sectors is measured by deriving data from the national accounts system and the standard structural business statistics (SBS). Further, four macro indicators are chosen to measure the economic weight of the blue economy sectors: turnover, employment, value added and exports. In addition, these macro indicators are analyzed and compared to national figures, such as the gross domestic product (GDP), gross value added (GVA), the national employment, and exports in order to gain an overview of the sector's relative significance within the Finnish economy.

This study shows that the six sectors of the blue economy generated in total a turnover between 14.6—20.2 billion euros, constituting roughly 3.5—4.9% of the national output, and created approximately 4—5.8 billion euros in value added, which covers over 2% from the national gross value added, and 1.8—2.6% from the gross domestic product. The sector employs somewhere between 53 000—71 000 people, which is 2—2.7% of the national employment of Finland. The share of exports from the national total is somewhere between 4—6.2%, and 3.5 to 5.4 billion euros. If compared to other industries in Finland, the blue economy sector is slightly larger than forestry measured by value added and possibly even larger than the forest industry, covering roughly 2.1—2.8% of the national GVA. In terms of employment, the proportion of the blue economy sector is slightly more than that of forestry and the forest industry combined, but less than that of agriculture.

To conclude, as the forest industry and forestry are commonly seen as central generators of economic wellbeing in Finland, it is important to acknowledge the significance of the blue economy sector. Future policies regulating the maritime should bear in mind the economic importance and potential of the sector, as well as its role in climate change mitigation and other environmental policy goals.

Keywords
Blue Economy, Marine Economy, National Accounts, Macro-indicators, Economic contribution

Where deposited:
ethesis.helsinki.fi

Additional information:
BlueAdapt www.blueadapt.fi

Tiedekunta/Osasto: Maatalous-metsätieteellinen tiedekunta		Laitos: Taloustieteen laitos
Tekijä: Heikkinen Essi Henriikka		
Työn nimi: Suomen sinisen talous – Määrittely ja taloudellisen merkittävyyden analyysi		
Oppiaine: Ympäristö- ja luonnonvaraekonomia		
Työn laji: Maisterintutkielma	Aika: Maaliskuu 2019	Sivumäärä: 76

Tiivistelmä:

Meriekosysteemeillä ja valtamerillä on elintärkeä rooli maailmassa. Lisäksi, koko historian ajan valtamerillä on ollut keskeinen rooli maailmantaloudessa kansainvälisenkaupan tärkeimpänä alustana sekä monien raaka-aineiden ja resurssien tarjoajana. Meriekosysteemien tilan heikkenemisen vuoksi merien ja valtamerien hyvinvointi on noussut monien maailmanlaajuisten ja alueellisten poliittisten aloitteiden keskiöön, jonka seurauksena uusia sinisen talouden kaltaisia käsitteitä on kehittynyt. Sinisen talouden käsitteen ja siihen kuuluvien toimialojen määrittelystä ei kuitenkaan ole selkeää yksimielisyyttä.

Yhtenäisen määritelmän puuttumisen vuoksi, ei sinisen sektorin taloudellisesta merkittävyydestä ole selkeää ymmärrystä. Jotta merien hyödyntämistä voidaan poliittisesti ja taloudellisesti säädellä mahdollisimman optimaalisesti, on tärkeää ymmärtää sinisen talouden toimialojen kokonaistaloudellinen arvo. Tämä tutkielma pyrkiikin määrittämään sektoriin kuuluvat toimialat ja arvioimaan niiden tämänhetkisen taloudellisen kontribuution Suomen kansantaloudessa.

Jotta sektorin taloudellinen arvo voidaan mitata, on sinisen talouden käsitteelle löydettävä yhtenäinen määritelmä ja tunnistettava sektoriin yleisimmin luettavat toimialat. Tämä on tehty laajaan kirjallisuuskatsaukseen pohjautuen, jossa kansainvälisiä meritaloutta mittaavia tutkimuksia vertailtiin keskenään ja tutkimuksille yhtenäiset ominaisuudet tunnistettiin. Sektorin taloudellinen arvo on määritelty hyödyntämällä kansantalouden tilinpidon-, yritysten tilinpäätös-, sekä matkailun-, että julkisen sektorin tilastotietoa. Neljä makroindikaattoria valittiin kuvaamaan sinisen talouden taloudellista arvoa: liikevaihto, arvonlisä, työllisyys sekä vienti. Lisäksi kyseisiä indikaattoreita verrattiin kansallisiin tunnuslukuihin kuten bruttokansantuotteeseen, bruttoarvonlisään, työllisyyteen sekä kansalliseen vaihtotaseeseen.

Tutkimuksen tulokset osoittavat, että sinisen talouden sektorit tuottavat noin 14—20 miljardin euron liikevaihdon, jonka osuus kansantalouden tuotoksesta on noin 3.5—4.9%. Lisäksi sektorin tuottama arvonlisä kattaa n. 1.8—2.6% Suomen bruttokansantuotteesta ja yli 2% bruttoarvonlisästä. Sinisen talouden työllisyys käsittää noin 2—2.7% koko Suomen työllisyydestä, ja vienti 4—6.2% koko kansantalouden viennistä. Muihin kansantalouden sektoreihin verrattuna, sininen talous on kooltaan hieman metsätaloutta ja mahdollisesti jopa metsäteollisuutta suurempi arvonlisällä sekä työllisyydellä mitattuna.

Yhteenvetona voidaan todeta, että koska metsätalous ja –teollisuus nähdään Suomessa yleisesti keskeisenä taloudellisen hyvinvoinnin tuottajana, on tärkeää, että yhtä suuren jollei jopa suuremman sinisen talouden sektorin taloudellinen merkitys huomioidaan politiikan teossa. Meripolitiikkaa säädettäessä olisi tärkeää huomioida alan taloudellinen merkitys ja potentiaali, sekä sektorin rooli ilmastonmuutoksen hillinnässä sekä muissa ympäristöpolitiikan tavoitteissa.

Avainsanat:
Sininen talous, meri talous, kansantalouden tilinpito, taloudellinen kontribuutio, makroindikaattorit

Säilytyspaikka:
ethesis.helsinki.fi

Muita tietoja:
BlueAdapt www.blueadapt.fi

Table of Contents:

Acknowledgements

The work regarding this thesis was funded by the Strategic Research Council of Academy of Finland and is conducted as part of the work of BlueAdapt. Blue Adapt is a joint research project by Demos Research Institute Ltd, the Finnish Environment Institute, the Finnish Meteorological Institute, University of Eastern Finland, University of Helsinki, and University of Lapland. Moreover, I want to thank Tapio Karvonen from the University of Turku, for his insights and help regarding the estimation of the maritime shares of certain economic activities included within the blue economy. Lastly, I am very thankful for the valuable advice, patience, and support I have received from my thesis instructor Markku Ollikainen.

List of Figures

List of Tables

List of Abbreviations:

BEC	Classification by broad economic categories
CPC	Cooperative patent classification
EMP	Employment
ESA	European system of accounts
EXP	Exports
GDP	Gross domestic product
GHG	Greenhousegas
GNP	Gross national product
GVA	Gross value added
ISIC	The international standard industrial classification
MEA	Maritime economic activity
NACE	Statistical classification of economic activities in the EU (Nomenclature Statistique des Activités Économiques Dans la Commonauté Européenne)
NOEP	National ocean economic program
NUTS	The nomenclature of territorial units for statistics (Nomenclature des Unités territoriales statistiques – NUTS)
PRODCOM	Statistics on the production of manufactured goods
R&D	Research and development
SBS	Structural business statistics
SITC	Strandard international trade classification
SNA	System of national accounts
SVT	Suomen virallinen tilasto, Official Statistics of Finland
TO	Turnover
UN	United Nations
VA	Value added
VAT	Value added tax

1. Introduction

Marine ecosystems and oceans have a vital role in sustaining life on Earth. The oceans generate half of the world's oxygen, regulate the global climate and temperatures, absorb carbon from the atmosphere, provide food security, nutrient cycling and storm protection. Further, the oceans create many options for recreational and cultural activities enjoyed by the humankind. These marine ecosystem services support the lives, livelihoods, and trades of the entire biosphere and help maintain life on earth. (Mendler de Suarez, et al. 2014.) Moreover, the oceans have an essential role in the world's economy as the principle platform for global trade as well as a provider of many raw materials and resources (Pendelton, et al. 2012).

Oceans are one of the most heavily exploited ecosystems in the world (Barbier, 2017). Due to the degradation of these marine ecosystems, the ecological status of the seas and oceans has risen to the forefront of many global and regional political initiatives and agendas. Consequently, new concepts linked to the maritime have evolved, such as that of blue economy. The notion of blue economy started as an expansion to the United Nation's framework for Sustainable Development and the promotion of the "green economy" concept. The inadequacy of the green economy concept for the Small Island Developing States initiated the process of preparing a "blue" approach to the green economy. Since then, institutional efforts have been made to expand the aspect of the blue economy. (United Nations, 2014.)

There is neither a unified definition of blue economy, nor a clear consensus regarding the economic activities the concept consists of, thus it is plausible to state there is no general perception of what the blue economy sector means for the national economy of a country. However, in many studies blue economy is understood as a set of economic activities that are either directly or indirectly linked to the ocean or benefit from a shore-adjacent location. These activities explore, develop, and use ocean resources; produce outputs for other ocean activities; use ocean space; or protect the ocean environment.

In order to efficiently and optimally regulate and manage the use of ocean resources and space, it is essential to understand the economic contribution and role of the marine-based industries in the national economy. This thesis strives to identify the industries regarded as part of blue economy to provide an economic analysis and description of the industries

in Finland. Furthermore, the aim is to find the most practical ways to measure the current economic contribution of the blue economy sector, and provide an estimate concerning its economic weigh in the context of the Finnish national economy. This study is the first attempt to measure the economic contribution of the Finnish blue economy sector at this scale.

In order to estimate the economic contribution of the blue economy sector, first the definition of the concept needed to be clarified. The approach used for defining the blue economy and the economic activities regarded as part of it, is a literature review. In the literature review, different studies are compared and analyzed, and as a result, the most common industries and maritime economic activities are identified to form the basis for the economic measurement of the sector. Adjustments to this classification of blue economy sectors are made, due to the fickle availability of industry data, and specific structural attributes of the respective country's national economy.

The economic contribution of the blue economy sectors is measured by deriving data from the national accounts system and the standard structural business statistics (SBS). Four macro indicators are chosen to indicate the economic role of the blue economy sectors: turnover, employment, value added and exports. Furthermore, these macro indicators are analyzed and compared to national figures such as the gross domestic product (GDP), gross value added (GVA), national employment, and exports, in order to gain an overview of the sector's relative significance within the respective economy.

This study shows that the blue economy sector accounts for over 2% of the national GVA, and between 1.8–2.6% of the gross domestic product. Furthermore, the sector covers roughly 2–2.7% of the national employment of Finland. The largest blue economy sector in terms of value added is the marine construction sector, but if measured by turnover and employment, tourism becomes the largest blue economy sector. Marine construction and transportation are the most significant sectors measured by exports.

Finally, when compared to other essential sectors of the Finnish national economy, the blue economy is comparable in size to forestry and forest industry. As the forest industry and forestry are commonly seen as central generators of economic wellbeing in Finland, it is important to acknowledge the significance of the blue economy sector. Future policies regulating the maritime should bear in mind the economic importance and

potential of the sector, as well as its role in climate change mitigation and other environmental policy goals.

The thesis is structured as follows. In the next chapter, I conduct a literature review as means to produce a consensus on the sectors regarded as blue economy and the methods used to identify these sectors. In section three, I move on to presenting the framework of national accounts and macroeconomic indicators applied to make sense of the economic contribution of the blue economy sector. Further, in section four, I present the selection of maritime economic activities (MEAs) for the Finnish economy and explain the methods for calculating the shares of partially maritime economic activities, as well as data extraction methods. In section five, I analyze the economic contribution of each blue economy sector by using the macro-indicators calculated and discussing their relative weigh within the national economy of Finland. In section six, I compare the different sectors of the blue economy and provide an economic overview of the blue economy sector, compare it to other relative economic sectors of Finland, and conduct an international comparison of the structural differences of the blue economy. In section seven, I discuss the economic relevance of the blue bio-economy sectors in Finland. Finally, in section eight I conclude the purpose, findings and limitations of this study and reflect on the need for further research.

2. Comparing definitions of the blue economy concept – a literature review

In order to quantify the economic contribution of the blue economy sector, one has to determine which sectors belong to it and how to measure their economic contribution. (Surís-Regueiro, et al., 2013). The lack of a unified method for defining the marine or ocean economy makes the comparison between regions and countries difficult. (Foley, et al., 2014.) Terminology used to describe the blue economy sector varies and is used in a different manner around the world. Concepts such as ocean industry, ocean economy, marine economy, marine industry, marine activity, maritime economy, the maritime sector, and maritime cluster are terms often discussed parallel to blue economy. (Park, 2014.)

The approach used here compares different studies measuring and defining the concept of blue economy (Appendix, Table A1), and summarizes the different classifications of

maritime economic activities (MEAs) found in literature (Appendix, Table A2). The summarization of MEAs provides a suggestion for the general understanding of what industries to include within the blue economy, which is modified to match the availability of statistical data, as well as the relevance of the sectors' economic impact in the national economy of each member state. The maritime economic activities most commonly identified in the studies are collected and presented in Tables A1, and A2 of the Appendix.

2.1. Classification Methods Found in Literature

The most common concept used in parallel to the blue economy in Europe is the marine economy. The concept of blue economy, or marine economy, covers all economic activities with a direct or indirect link to the ocean. Furthermore, the definition includes a geographical aspect as activities located within the marine environment, or at close proximity from the shore, are generally regarded as part of the blue economy. The geographical criterion for land-based activities that directly support marine-based activities (EASOS, 2014), or benefit from the shore-adjacent-, coastal location, (Maritime Affairs and Fisheries, 2018) is defined by either using the EU's hierarchical system for the division of economic territories of the EU (NUTS) or by applying territorial limits based on municipal distances from the sea. (Maritime Affairs and Fisheries, 2018; Foley et al., 2014.)

To compare, the most commonly used notion for blue economy in the United States and Ireland is ocean economy. The United States refer to the marine economy as ocean economy because it distinguishes ocean economy from the coastal and land-based economy. Colgan (2003) defines coastal economy as the summarization of economic activities taking place in the coastal regions and utilizes data on wages, employment and output in the region. A part of coastal economy pertains within the ocean economy; however, coastal economy consists of a much broader variety of economic activities. Ocean economy, in contrast, consists of economic activities that receive all or a part of their inputs from the ocean or the Great Lakes, and work as a function of industry and geographical location. (Colgan, 2003.)

There are studies that compare and analyze international terms and classifications used in relation to ocean-based economic activities, and compile categories based on the most common characteristics. (Park, 2014; Surís-Reguiero, et al. 2013; Morrissey, et al. 2011) The scope of the concept is defined by comparing the varieties of maritime economic

activities (MEAs) linked to the notion of blue economy. The number of MEAs varies from three to more than 50, which highlights the differences between classifications of sectors and categories amongst countries. Generally, these studies suggest that a marine-based economy is a combination of activities directly or indirectly taking place in the ocean, using outputs from the ocean, or producing goods and services required to develop an activity linked to the maritime. (Park, 2014; Surís-Reguiero, et al. 2013; Morrissey, et al. 2011; Pugh and Skinner, 2002; EASOS, 2014.)

Commonly, the marine industries and MEAs are identified by the latest statistical nomenclature of NACE (second revision) used within the European Union. The classification is given at a four-digit level, which allows for the identification of activities that have different relationships to the maritime. The problem with using the NACE classification system lies in its functionality, since the system does not establish the difference between maritime and non-maritime economy but rather defines the nature of the activity. The current classification system of economic activities does not take into account the blue economy as such; therefore, the measuring of several maritime sectors becomes problematic due to the lack of data, or assumptions made to estimate the marine-based values of the sector. (EASOS, 2014.)

Most studies divide the identified MEAs into groups based on their marine-linkage. Some studies differentiate MEAs between completely marine, mainly marine, and only partially marine activities (Foley et al., 2014; Park, 2014). Usually, activities that are considered fully marine, are activities that directly use inputs from the ocean, or are performed at or in the sea, whereas marine linked activities produce inputs for marine specific activities; use inputs from the marine specific activities; or are located near the sea or in coastal regions.

Typically, the activities that are only partially marine, have a rather insignificant marine presence and are minority activities within their industry NACE code, although a coastal location can increase the probability of belonging to the marine economy, yet most of the turnover can still depend on processes not directly related to the sea. (Park, 2014.) The categorization of MEAs can also be done by the type of an activity's end product, for example marine services or manufacturing (Morrisey et al. 2011). If the economic activities can be considered to be completely maritime, the quantification of the activities is simple and consistent, but if the activities are only in part maritime, disaggregations

and estimates on data need to be made between regions and activities (Surís-Reguiero et al., 2013; Maritime Affairs and Fisheries, 2018; Vega et al., 2013).

To compare, the National Ocean Economic Program (NOEP) uses a classification method based on official United States statistical data sources and surveys. NOEP categorizes ocean economy into nine main sectors, although available data for only six of these can be found. In this methodology, economic activities are identified with codes corresponding to the Standard Industrial Classification method (SIC), and the North American Industrial Classification system (NAICS). The SIC system classifies each enterprise in terms of its main line of business, whereas the NAICS system does this classification based on the activity the company carries out. Therefore, the NAICS system provides detailed and precise information regarding industries and enables the closer investigation of MEAs. These classification systems are used by the NOEP methodology to quantify the contribution of MEAs in the national economy.

The NOEP method is based on Colgan's (2003) estimations on the weight of economic activities linked to the ocean, which are restricted by the lack of available data; conceptual complication; and choices regarding the selection of economic activities to include and exclude from the blue economy. Colgan (2003) argues that the consistency of measures used across regions should be based on economic theory, double counting should be avoided, and data collection processes should be made replicable. The NOEP methodology follows these conditions with its objectives regarding comparability across industries, consistency of data nationally, locally and over time. The contributions of these economic activities are measured in terms of GDP, employment and wages. (Surís-Reguiero et al., 2013.)

Even though the general understanding of the criteria for the selection of economic activities is fairly coherent among European studies, the identification methods of sectors and MEAs, as well as their variety vary significantly as can be seen from Tables A1 and A2 (Appendix). Moreover, it should be noted that large parts of the blue economy sector can be placed in adjacent economic activities, outside the core sectors. For instance, when considering maritime transport, the economic activity considered is often shipping itself, but in fact, most of the value added created can be traced to ports, shipyards and supply industry activities, as well as related services. Therefore, a supply chain based classification method for economic activities is suggested. When industries are

interlinked they form a supply chain, thus the classification method of MEAs could include deciding which part of each supply chain to include or exclude from the blue economy and whether it is wise to merge these activities into an aggregate industry. (Park, 2014.) Including the upstream value chain in the economic analysis of the sector can add significantly to the overall value of the industry and act as a multiplier without tremendously increasing the pressure on the ecosystems (Roberts & Ali, 2016).

Primary data sources used in most studies are publically open, official national statistics or data compiled by Eurostat (Morrissey et al., 2011; Pugh & Skinner, 2002; Kalaydijan et al., 2009; Foley et al., 2014; EASOS, 2014; Maritime Affairs and Fisheries, 2018). Furthermore, some studies utilize data derived from national governments and ministries (Kalaydijan et al., 2009; Pugh and Skinner, 2002). When primary data is not available, some only apply explicit alternate data techniques (Pugh & Skinner, 2002), whereas others turn to data from businesses and other professional organizations (Kalaydijan et al., 2009).

Indicators used to measure the contribution of the blue economy sector are often derived from the structural business statistics and include values for turnover, value added, employment, exports, number of enterprises and additional socio-economic variables. (Foley et al., 2014; Morrissey et al., 2011; Kalaydijan et al., 2009; EASOS, 2014). Additionally, estimations on ratios such as GVA to turnover, average wage, profit margin and labor productivity are calculated and analyzed (Maritime Affairs and Fisheries, 2018).

Finally, in order to estimate the maritime share of only partially marine economic activities, additional sources of criteria are implemented on the data (e.g. regarding location or significance in value chain). The maritime proportion of the economic activity in Europe can be measured by using PRODCOM codes that provide more detailed information about the production of manufactured goods, however; these statistics do not provide any data on services or company turnover (EASOS, 2014). Sometimes mere assumptions are used as proxies of the maritime share of a certain activity (Maritime Affairs and Fisheries, 2018) or more detailed data is sought from sectorial reports, studies, and surveys (Morrissey et al.,2011; Kalaydijan et al., 2009).

2.2. Identified blue economy sectors and MEAs

The scope of the blue economy depends on the sectors included in the analysis and available data. The most common economic sectors included in different studies are: fisheries, aquaculture, tourism, shipping, biotechnology, maritime security, mining and the extraction of oil and gas, as well as renewable energy (Table A2). (Roberts & Ali, 2016.) Often these industries are divided into sectors such as the living resources and the non-living resources, shipbuilding, construction, transport, tourism and recreation, public administration, education as well as research and development (Surís-Reguiero et al., 2014).

To summarize, the activities linked to the definition of the blue economy sector should include activities that are directly or indirectly linked to the ocean (or other major aquatic ecosystems) and therefore:

I. Take place in or around the ocean and use ocean space
II. Are located near the shoreline and benefit from the shore adjacent location (e.g., coastal tourism)
III. Activities that produce outputs (goods and services) for industries/activities that are tied to the ocean (e.g. shipbuilding, cruise operators, etc.)
IV. Activities using ocean resources as input
V. Activities exploring and developing ocean resources
VI. Activities protecting or restoring the ocean environment and ecosystem

(Reference by: Roberts & Ali, 2016)

Due to the recent degradation of the ocean environment and the severe consequences of the contamination of these ecosystems, the blue economy industries could be increasingly adjusted and steered towards more sustainable conventions. Additionally, efforts should be made to include estimates of the economic value of these ecosystems to the economic measurement of the sector.

In order to fully understand the economic importance and potential of the blue economy sector, a holistic and comprehensive list of economic activities linked to the blue economy is provided in Table A2 in the Appendix. The table presents a selection of maritime economic activities that three or more marine economy studies identified with the same

NACE-classification code. These sectors constitute the core MEAs forming the definition of blue economy. Studies by Park (2014) and Roberts & Ali (2016) presented in section 2 were left out of the cross-study comparison, due to a lack of identifiable NACE codes or other comparable statistical codes. For studies using different classification codes as opposed to NACE, statistical conversion tables were used to identify similar sectors.

All in all, 55 maritime economic activities occur more often than not in the literature introduced. This identification of economic activities presented in Table A2 (Appendix) is a comprehensive representation of the most common MEAs regarded as blue economy, and therefore functions as a valid basis for the measurement of the sectors economic contribution. Where possible, I include the selected activities in the economic analysis at the fourth NACE level. For some activities, data for the selected macroeconomic indicators is not available at this level, thus additional data sources and aggregate data is used. I divide the 55 economic activities identified into nine sectors: the living resources, non-living resources, transportation, ports, shipbuilding, manufacturing, tourism, the public sector, education and R&D.

The living resources sector includes activities such as fishing and aquaculture (practiced both at sea and in freshwaters), fish processing, as well as fish retail and wholesale. The non-living resources sector consists of extraction and production activities of oil and gas, mining and quarrying activities, and the sale of industrial equipment. These activities are included in the blue economy sector only for the part of the activity that is operated in or at sea. For some countries, these economic activities are significant contributors to the national economy, but for the case of Finland the role of this sector is marginal, if not non-existent.

The transportation sector consists of both passenger and freight water transportation activities at sea and inland, as well as renting of water transportation equipment. Moreover, insurance activities typical for water transportation and shipping activities are included in this sector. The ports and shipbuilding sectors include activities from port operators and cargo handling to water construction and shipbuilding. The manufacturing sector accounts for hydro and wind power production, transmission services of electricity, and the manufacture of engines and turbines - an essential activity for the shipbuilding sector.

The tourism sector includes a variety of economic activities, not specifically maritime, but nonetheless important for the traveling sector. These activities are regarded geographically as part of coastal tourism and consist of accommodation providers, food and beverage activities, as well as travel agency and tour operator activities.

The public sector, as well as sectors for marine education and -research and development consist of activities related to national defense, water handling and supply, waste and sewage handling, education, engineering, and technical consultancy activities, as well as research, development and other technical activities. There is little economic data regarding national defense, public administration, education, and research and development that is easily included in the partially maritime activities, which makes a reliable measurement of the economic importance of this blue economy sector difficult.

3. Framework: Macro-indicators and The System of National Accounts

The framework used in this study is based on the system of national accounts. The system of national accounts works as a foundation for both the classification of the sectors and industries included in the concept of blue economy, as well as data extraction. In order to measure the economic contribution of the blue economy sector, the economic activities it consists of were identified. This identification of MEAs was conducted on the basis of a literature review but is further modified based on the system of national accounts.

This modification is necessary to represent and include the most relevant sectors for the Finnish economy in the analysis. For instance, sectors such as oil and gas exploration and extraction are not essential in the Finnish economy and thus, are not statistically compiled in the national accounts, but are commonly identified as part of the blue economy sector.

All data in the national accounts system regarding economic activities are presented and classified based on the NACE classification system introduced here. Finally, the macroeconomic indicators used to measure and describe the economic weight and contribution of the blue economy sector are explained.

3.1. The System of National Accounts

National accounts is a statistical system that measures variables explained by macroeconomics. The system is based on the national economy circulation flow diagram, which describes the flow of money, goods and services between different agents. The value of this flow can be measured by three different indicators: gross domestic product (GDP), gross national product (GNP) and the use of GDP. Thus, the national flow of goods can be described by output, income and end-use. (Burda & Wyplosz, 2001:20–23.)

Additionally, in an open economy that is involved in foreign trade, exports and imports need to be accounted for. In the national accounts system national economy is defined by domestic economic units, domestic referring to units that operate in the respective country for one year or longer. Therefore, units of Finnish enterprises operating abroad are not considered a part of the Finnish national economy, whereas the units of foreign enterprises operating within Finland are.

The system of national accounts is produced and maintained by the Statistics Finland. Finland uses EU's common accounting system called the European System of Accounts (ESA), which is based on the UN's globally standardized recommendation System of National Accounts (SNA).

The central components of the national accounts are the detailed yearly accountancy, and the more general quarterly reported accountancy. Furthermore, Statistics Finland produce a monthly published trend indicator of outputs. In addition, various specialized accounts describing the state and development of finance, capital stock, regional economics and productional dependencies are used to complement the system of national accounts. This information system is a compilation of different statistics, registers and data gathered from households and firms through queries. (Pohjola, 2015: 132–133.)

3.2. The Nomenclature of Economic Activities (NACE)

The statistical classification of economic activities, in short NACE, is used to identify and classify the economic activities incorporated in the blue economy. NACE is the standard industry classification system used in the European Union. All data in the national accounts system regarding economic activities are presented and classified based on the NACE system. (Eurostat, 2008.)

The NACE system assigns second, third and fourth level codes to each industry. The first level assigns an alphabetical code to a heading, for example, A) agriculture, forestry and fishing. The second level identifies headings by assigning a two-digit numerical code to a division, for example, A - 03 "Fishing and Aquaculture". The third level divides the division into groups by identifying a three-digit numerical code for the group. Finally, the fourth level further divides the groups into classes by assigning a four-digit code to the class (e.g. A- 03–11 "Marine fishing") differentiating the economic activities with more detail. (Surís-Regueiro, et al., 2013; Eurostat, 2008.) The fourth level allows for a more detailed separation of maritime economic activities from land-based economic activities, although data recorded on this level is often scarce.

The NACE classification system is based on the integrated system of statistical classifications (ISICS), which is administered by the United Nations Statistical Division. The ISIC and NACE system are identical at the highest level (second level) of classification, NACE providing more detail at the lower classification levels. NACE Rev.2 (second revision) highlights the importance of the production process of an activity in the classification process, grouping together activities that share a joint production process utilizing similar technologies.

Additionally, the classes of the European nomenclature system are defined in a way that the production of the goods and services grouped together account for the bulk of the output of the units categorized in that class. Further, the units contained in the class account for most of the production of the category's goods and services. In the NACE system, classes are defined for activities that are prevalent in most EU-countries.

The international family of economic classification systems is composed of three main types of classifications: reference derived and related classifications. Reference classifications, such as ISIC, are classifications that are formed by international agreements approved by the UN's Statistical Commission or another intergovernmental board. Reference classifications are broadly accepted and recommended as guidelines of economic classification methods. NACE is a derived classification that is based on the reference classifications. These types of integrated and widely acknowledged classification systems advance the comparability of statistics from different domains. (Eurostat, 2008.)

3.3. Macro Indicators

The system of national accounts provides systematic and the most reliable data for the comparison and measurement of economic development and -changes.

One approach to measuring the value of national accounts is to multiply the amount of produced goods and services with their prices, ergo the gross domestic product (GDP). GDP is the monetary sum of end products produced in a national economy within a year. It is important to note that only end products are calculated within the GDP. Since intermediates are excluded, another way to derive the value of the gross domestic product is to sum the added values of all enterprises. Most often GDP is calculated using market prices, but it can also be predicated using the production volumes of the examined year and multiplying them with basic year prices. By comparing the base-year and current price GDPs, the development of price levels can be observed.

While GDP represents the collective income earned within a nation's boundaries, gross value added (GVA) provides an output approach to the calculation of the GDP. GVA calculated by industry, works as an indicator of structural changes within an economy. (Pohjola, 2015;135–138, Burda & Wyplosz, 2001; 20–39.)

The four macroeconomic indicators common to all economic activities are chosen to describe the economic contribution of the individual sectors and industries: turnover, value added, employment and the share of exports. I use these indicators due to their rather consistent existence in the statistical compilation of data, as well as their descriptive qualities. Moreover, these indicators are used in most studies measuring the economic role of blue economy.

Turnover was chosen as an indicator because it provides a general understanding of the scale of the respective MEA compared to the industry it is a part of. Turnover comprises the total invoiced income of the enterprise, corresponding to the total value of sales to third parties after the deduction of a VAT-tax, whereas income is the amount of money a company makes after all reductions are made. Furthermore, the gross output measures the total value of production within an accounting period before the subtraction of intermediates, and is therefore roughly comparable to turnover.

Value-added indicates the economic contribution of an enterprise or an industry over the the value of input it uses. It is derived by deducting the intermediates used in the

production of the good, and adding the compensations of employees; consumption of fixed capital; as well as possible taxes on production and imports. (Kansantalouden tilinpito - käsitteet ja määritelmät, 2019.) A firm thus creates value added by transforming raw materials and unfinished goods into products to sell in the markets. The value added of an MEA or an industry can be compared to the national values of GDP and GVA. A ratio of an industry's value added as well as the national values can be calculated to provide an estimation on the contribution of a sector to the national economy.

The number of persons employed is the full-time equivalent (FTE) describing the labor input of a person working full time at a company, including all paid hours divided by the average paid hours of full-time salary earners. In the presence of structural unemployment, employment rates can be used to analyze an industry's employment effects and relevance in regards to employment policy. Here employment figures are compared to the national employment values to estimate blue economy's contribution to the national employment of Finland. (Kansantalouden tilinpito - käsitteet ja määritelmät, 2019.)

Foreign trade is essential to any open, small economy such as Finland. Exports describe the transactions of goods and services from a respective country to abroad. The balance of current accounts is an indicator of the structure of an economy as well as a measure of its foreign trade. The balance of current accounts measures the sum of the balance of trade, net income from abroad, as well as net current transfers. A surplus in the current accounts indicates growth in a country's net foreign assets, which means that the economy receives more income from its foreign transactions than expenses. A deficit on the other hand, indicates that a country's imported goods and services exceed the volume of exported goods and services. By measuring and comparing the share of exports of a sector or an industry to the share of exports of a national economy, the contribution of an industry to the outbound foreign trade can be estimated. (Burda & Wyplosz, 2001; 32–35, 116–117.)

The national shares of employment, gross value added (GVA), gross domestic product (GDP), and gross national output of each blue economy sector are calculated to provide an understanding of the relative economic contribution of each sector, and are used for sectoral comparison.

Furthermore, ratios for turnover, employment, value added and exports are calculated to provide insight to the dynamics between these macro-indicators. The turnover to employee ratio of an economic activity imparts roughly how much turnover one full-time employee produces. This ratio indicates broadly the productivity of an employee. Similarly, the value added ratio describes the rate at which inputs are turned into outputs. (Barthwal, R., 2004; 519-522.) Moreover, the value added-, and export to turnover ratios are calculated. Value added to turnover indicates how much a unit of turnover creates added value for the company. Since value added is revenue deducted by the usage of intermediates of an industry, the ratio describes how much end-use revenue a unit of turnover creates. Finally, the export to turnover ratio shows how much from a unit of turnover derives from international trade.

4. Methods and data

I start with the selection of maritime economic activities (MEAs) fitting best to the Finnish economy, and then present the key delineations regarding the selection. I then move on to describing the use of approximates for measuring the partially maritime sectors and finally, data sources and extraction methods are explained. The methods used in this thesis are compiled from the different techniques of studies calculating the economic importance of the blue economy presented in the literature review of this thesis.

4.1. Definition of the Finnish Blue Economy

The first task regarding the economic analysis of the blue economy sector has been the definition of economic activities. I conducted a comprehensive literature review to identify the most common MEAs regarded as blue economy. As stated before, altogether 55 economic activities were selected, providing a valid basis for the measurement of the sector's economic contribution. This selection is modified to overcome issues regarding data availability, and to match the sector's economic relevance within the national economy of Finland. The MEAs I selected for the analysis of the Finnish blue economy are presented in Table 1.

Table 1. Maritime economic activities for the Finnish blue economy

Living resources	A0311 Marine fishing A0312 Freshwater fishing A0321 Marine aquaculture A0322 Freshwater aquaculture C1020 Processing and preserving of fish, crustaceans and molluscs G4723 Retail sale of fish, crustaceans and molluscs G4638 Wholesale of other food, including fish, crustaceans and molluscs
Marine industry	
Ports	H52100 Warehousing and storage H52221 Harbors H52229 Other supporting water transport activities H52240 Cargo handling H52291 Forwarding and freighting H52299 Activities of other transport agencies
Manufacture	C24 Manufacture of basic metals C25 Manufacture of fabricated metal products, except machinery and equipment C26 Manufacture of computer, electronic and optical products C27 Manufacture of electrical equipment C28 Manufacture of machinery and equipment n.e.c. C29 Manufacture of motor vehicles, trailers and semi-trailers C301 Building of ships, boats and floating structures C3315 Repair and maintenance services of ships and boats F4291 Construction of water projects J62 Computer programming, consultancy and related activities J63 Information service activities M70 Activities of head offices; management consultancy activities M71 Architectural and engineering activities; technical testing and analysis M74 Other professional, scientific and technical activities
Transportation	H50101 Sea passenger transport H50102 Coastal passenger water transport H50201 Sea freight water transport H50202 Coastal freight water transport H50300 Inland passenger water transport H50400 Inland freight water transport N77340 Rental and leasing of water transport equipment
Renewable energy	D35111 Production of electricity with hydropower and wind power D3512 Transmission services of electricity
Insurance services	K6512 (65123) Non-life insurance (Marine, aviation and other transport insurance services) K6520 Reinsurance services K66220 Activities of insurance agents and brokers
Other	C323013 Water-skis, surfboards, sailboards and other water-sport equipment G46140 Agents involved in the sale of machinery, industrial equipment, ships, aircraft G46495 Wholesale of boats and boating accessories and aircraft G47642 Retail sale of boats and boating accessories and aircraft
Tourism	I5510 Hotels and similar accommodation I5520 Holiday and other short stay accommodation I5530 Camping grounds, recreation vehicle parks and trailer parks I5590 Other accommodation I5610 Restaurants and mobile food service activities I5630 Beverage serving activities N7721 Renting and leasing of recreational and sports goods N7911 Travel agency activities N7912 Tour operator activities R9312 Activities of sports clubs R9329 Other amusement and recreation activities
Public sector	E3600 Natural water; water treatment and supply services E3700 Sewerage E3900 Remediation activities and other waste management services O8411 General public administration activities O8422 Defense activities O8424 Public order and safety activities
Education, R&D	M7200 Research and development M7211 Research and development of biotechnology P85 Education
Reference after:	(EUNETMAR, 2013; EASOS,2014; Ecotec, 2006; Maritime Affairs and Fisheries, 2018; Foley et al., 2014; Innovamar, 2011; Kalaydijan et al., 2014; Pohjola et al, 2018; Pugh & Skinner, 2002; Surís-Reguiero et al., 2013; Vega et al., 2013)

The classification for the living resources-, tourism-, public- and education sector, is the one based on the literature review in section 2 of this thesis. However, as most of the tourism-related activities do not have a direct link with the oceans or freshwater reserves, I apply a regional delineation. Tourism-related activities within coastal areas as defined by the EU's geographical classification system NUTS-3 as activities benefitting from a shore-adjacent location and are regarded as part of blue economy sector.

The main MEAs for the 'marine industry' sector were selected by identifying the industries included in the Finnish maritime cluster concept and value chain, and clarifying what economic activities the concept consists of (Karvonen et al. 2016; Prizztech, 2016). The economic activities included in the marine industry were selected based on the most frequently used NACE-codes among the companies interviewed in the industry report (Prizztech, 2016). After identifying the most common NACE-codes among the companies, their weight in the industry value chain was analyzed by looking at the national input-output tables of supply and usage. Finally, the most economically significant activities serving the offshore sector were selected. (Karvonen et al. 2016; Prizztech, 2016.)

As the blue economy sectors are inter-connected with multiple other sectors through suppliers and other linkages, a value-chain approach is applied in the selection of MEAs. One example to illustrate this inter-connectedness is the maritime transportation industry. Maritime transportation requires ships, boats and ferries to operate, whereas shipbuilding activities require material supplies for metal, steel, fuel, motor and propulsion systems, as well as electric and other components. Manufacture of motors, electric components or metals is not a maritime economic activity, but operates within the value chain of an activity with a direct link to the maritime – a demand shock in the maritime transport industry affects the shipbuilding industry as well as the metal industry. (Karvonen et al. 2016; Prizztech, 2016)

Additionally, key market sectors in the offshore industry, relevant to the marine industry, include sectors such as offshore technology, subcontractors, shipyards, and engineering. In the offshore technology sector, the largest companies operate in the propulsion- and motor technologies sector. Other offshore technology companies comprise of marine technology companies and companies who have a background in other industries such as design and engineering, cranes and lifting, living and well-being, automation, electrical

solutions, process technologies, and HSEQ (health, safety, environment & quality) technologies. Subcontractors of the offshore industry include technology, as well as component and material suppliers, whereas the sector "others" include service companies. (Prizztech, 2016.)

One of the six main segments of the Finnish marine cluster is the classification- and financing facilities, as well as insurance companies. Classification facilities are private institutes that categorize ships into classes and provide them with a certificate. The primary purpose of the certificate is to determine the safety and seaworthiness of the ships for insurance companies, authorities, charters, and passengers. (Seutukaupunkiverkosto (T50), 2018.) Unfortunately, no data regarding classification facilities is found in the Finnish national statistics, which is why it is left out of the sector classification.

As to insurance companies, according to Karvonen, a significant share of the activities of insurance agents and brokers derives from the maritime sector (Karvonen, 9.3.2018; personal communication via email.) In addition, re-insurance and non-life insurance activities were included in many studies measuring the economic significance of the blue economy sector. Approximately 80% of foreign trade and 90% of exports is transported via sea. Ensuring ship equipment, utensil, and cargo is essential due to the masses of valuable goods transported in and out of national ports. (Karvonen, et al., 2016.)

Some changes to the presented classification of MEAs in Table A2 (Appendix) are evident for the case of Finland. These changes are mainly due to the lack of detailed industry data and the structure of Finland's national economy. For example, the industry of prepared meals and dishes is left out of the analysis since the supply of the sector for the fishing and aquaculture is merely 0.002% and can thus be regarded as insignificant. As to the non-living resources sector, no financial data is available for the extraction of crude petroleum and natural gas. For gravel and sand pit operations, as well as other mining activities, financial data is available, but these activities are left out of the economic analysis due to the difficulty of evaluating the maritime share of the sector. Additionally, the construction of other specialized projects -industry was left out of the analysis due to its marginal relative maritime share.

Due to similar reasons regarding data availability and extraction, an aggregate industry named the "marine industry" was created. This sector combines the transportation, ports, shipbuilding and manufacture sectors. These aforementioned industries are included in

the marine cluster concept, well represented in the Finnish literature, regarding the marine sector.

Moreover, the economic activities that are included in the national tourism accounts differ from the sector classification used in this study. The tourism accounts include the following industries in the classification: hotels and other lodging services, accommodation associated with vacation home ownership, food and beverage service activities, travel agency and tour operator activities, water, land, railway and air-passenger transportation, transport equipment rental services, cultural services, as well as sports and other recreational services. Transportation methods other than water-based are left out in the economic analysis of this thesis. As for water transportation, it is included in the economic analysis of the marine industry similarly to transport equipment rental services. Additionally, cultural services and accommodation associated with vacation home ownership are left out from the tourism sector in this analysis. (Business Finland, Visit Finland, 2018.)

Due to the unavailability of detailed data regarding the public sector some activities are left out from the initial selection of MEAs (Table A2). Furthermore, water treatment and supply services industry, which can be fully included in the blue economy, is accounted as part of the blue economy analysis. Additionally, many of the activities regarded as part of blue economy (e.g. activities associated with education, manufacture or tourism), are only partially linked to the maritime and thus consist of parts that cannot be included in the blue economy sector as such. The marine-based data is difficult to extract from these activities and can therefore affect the measurement of the size of the blue economy sector.

Finally, in order to fulfill the existing definitions for the blue economy that entail conditions for sustainability, as well as preserving and restoring the nature, some amendments and adjustments should be made to the classification of economic activities. For this reason, water-based environmental protection activities are included in the economic analysis of the sector. It should be noted, that not all economic activities benefitting from the ocean are sustainable or practiced in such a way, but are generally regarded as part of the blue economy.

4.2. Maritime- and industry share estimates

The second step in the measurement of the economic contribution of the blue economy sectors, is to estimate how much of the macro-indicator values derive from maritime-based operations.

Due to the lack of detail in the input-output tables, data for some industries could not be extracted, thus proxies regarding the maritime share of the industry's turnover could not be calculated. In order to provide sensitivity analysis, an arbitrary three-level estimate was produced by extending the calculated (or provided) estimate with higher- and lower percentage values.

It should be pointed out that the ratios used to calculate the direct contribution of the partially maritime industries to the blue economy are only rough estimations. Further, these proxies are based on values of turnover and output, and likely do not represent the correct estimates of employment as these macro-indicators do not necessarily exist in the same proportion.

Apart from the value added and export values, the macro-indicators are directly derived from official statistics and industry reports. Ratios describing the interrelationships of the indicators were calculated by simple division operation. Gross value added (GVA) is defined as output at basic prices (reference year market prices) minus intermediate consumption at purchaser prices. Furthermore, output at basic prices is the total amount of products produced in the accounting period, valued as produced.

4.2.1. Estimates for the Living Resources Industry

As the living resources sector consists of activities such as fishing, aquaculture, seafood processing, as well as wholesale-, and retail sale of fish, that can be regarded as fully maritime, macro-indicators can be directly derived from the statistics, no estimates are needed. However, values concerning the exports of wholesale-, and retail sale of fish, as well as value added of freshwater fishing, were not statistically available.

I produced the export values by dividing the turnover of the MEAs with that of the aggregate industries, and multiplied the aggregate export values with these turnover shares. The share of wholesale of fish from the aggregate industry comes to approximately 0.53%, whereas the retail sale of fish equivalent is around 0.40%. I

calculated the value-added estimate for the freshwater fishing industry by applying the value added to income ratio of marine fishing, which is roughly 52%, and multiplied the freshwater fishing income with this ratio. It is assumed here that the value added ratio is comparable between these two economic activities, due to their similar characteristics. (Kaupallinen kalastus sisävesillä (SVT), 2014; Kaupallinen kalastus merellä (SVT), 2018)

4.2.2. Estimates for the Marine Industry

Harbors, cargo handling, warehousing and storage, forwarding and freighting, as well as activities of other transport agencies and supporting activities are included in the "Ports" sector. Majority of these activities are only partially maritime, and thus cannot be wholly calculated as a part of the blue economy. As no sufficient data is available to calculate the marine share of these activities, the estimations regarding the maritime shares are based on an expert assessment (Karvonen; 9.3.2018, personal communication via email). As this assessment is only directional, a three-level estimate (low, medium and high) is provided to offer sensitivity analysis. The guesstimated estimates are referred to as medium estimates. I then extend these medium proxies with slightly lower and higher percentage values.

No estimations are needed regarding the maritime share of turnover and employment of activities considered fully maritime. The value-added and export shares were produced by dividing the MEA's turnover with the industry's aggregate turnover. I then multiplied the value-added and export values with this industry share.

A partially-maritime industry's marine-based supply was calculated to derive the maritime share of the respective industry. I performed this calculation by using the input-output tables of national accounts. I apply the value-chain approach by calculating a product group's marine-based supply (e.g. manufacture of metal products) by summarizing the supplies to other blue economy sectors (e.g. ship building, water construction etc.). In this addition operation, the maritime share of the respective blue economy sector was used to calculate the product usage. Further, the derived sum for supply was divided by the total aggregate supply of the respective product group. The percentage derived is the maritime share of the respective industry. Finally, I multiply the macro-indicators of an economic activity with the determined maritime proxy of the

industry. Again, in order to estimate the economic activity's contribution to the aggregate industry's value added and exports, the turnover of the MEA is divided by the industry's total turnover.

Due to the uncertainty of these maritime shares, there are significant differences between the derived macro-indicators and the ones presented in the maritime cluster industry report (Karvonen et al., 2016). This is why I apply additional maritime shares for sensitivity analysis for the marine construction sector. These additional proxies are derived from the offshore industry report (Prizztech, 2016). The maritime shares presented by Prizztech (2016), are assumed based on queries conducted for the offshore companies interviewed. Economic activities in the report were grouped to subcontractors, material suppliers, technology-, as well as design- and engineering companies. In order to specify which economic activities belong under which category, I researched the nomenclatures of the companies presented under each group.

The calculated maritime shares and the additional (Prizztech, 2016) shares applied for the Marine industry can be seen from Table 2. The estimates in the parenthesis are the low, medium and high appraisals. The first marine construction estimates in Table 2. are the ones calculated from the input-output tables, whereas the other estimates are the ones derived from the Prizztech report (2016).

Table 2. Maritime shares of the Marine industry

Transportation, Ports, Construction			**Maritime share, %**
Transportation	50101	Sea passenger transport	100
	50102	Coastal passenger water transport	100
	50201	Sea freight water transport	100
	50202	Coastal freight water transport	100
	50300	Inland passenger water transport	100
	50400	Inland freight water transport	100
	77340	Rental and leasing of water transport equipment	100
Ports	52100	Warehousing and storage	estimate less than 10% (3,5,7)
	52221	Harbours	100
	52229	Other supporting water transport activities	100
	52240	Cargo handling	estimate more than 50% (50, 52,54)
	52291	Forwarding and freighting	estimate less than 50% (50, 48, 46)
	52299	Activities of other transport agencies	estimate less than 10% (3,5,7)
Marine Construction	24	Manufacture of basic metals	(input-ouput tables) / Prizztech, 2016) 2,3 / 2

	25	Manufacture of fabricated metal products, except machinery and equipment	1,86 / 18
	26	Manufacture of computer, electronic and optical products	0,58 / 9
	27	Manufacture of electrical equipment	0,8 / 9
	28	Manufacture of machinery and equipment n.e.c.	1,15 / 9
	29	Manufacture of motor vehicles, trailers and semi-trailers	1,53 / 9
	301	Building of ships, boats and floating structures	100
	3315	Repair and maintenance services of ships and boats	100
	4291	Construction of water projects	100
	62	Computer programming, consultancy and related activities & 63 Information service activities	1,10 / 5
	70	Activities of head offices; management consultancy activities	0,85 / 5
	71	Architectural and engineering activities; technical testing and analysis	3,3 / 5
	74	Other professional, scientific and technical activities	0,4 / 5
	Energy, Insurance, Trade		**Maritime share, %**
Energy	35111	Production of electricity with hydropower and wind power	97,3
	3512	Transmission services of electricity	7,26
Insurance	6512 (65123)	Non-life insurance (Marine, aviation and other transport insurance services)	1,59
	6520	Reinsurance services	estimate less than 10% (1,59; 2; 3)
	66220	Activities of insurance agents and brokers	estimate less than 50% (50, 40, 30)
Trade	323013	Water-skis, surfboards, sailboards and other water-sport equipment	1
	46140	Agents involved in the sale of machinery, industrial equipment, ships and aircraft	0,01808
	46495	Wholesale of boats and boating accessories	1
	47642	Retail sale of boats and boating accessories	1

Further, I determined the marine share in energy production by calculating the percentage of the production capacity of hydro- and coastal wind power from the total electricity

production capacity of Finland. Hydropower is fully included in the blue economy; thus 100% of the hydropower production capacity is included in the combined share.

I estimate the contribution of coastal wind power by calculating the production capacities of all the wind power parks in coastal areas of Finland, defined by NUTS-3 area codes. The data for these calculations is derived from the Finnish Energy Authority's power plant register, which was updated in June 2018. There are 430 registered power plants in Finland, from which 142 are wind power producers. Altogether 115 of these wind power producers are located in NUTS-3 coastal areas. Based on this, coastal wind power accounts for approximately 81% of the total wind power production capacity. Moreover, these shares are used to calculate the maritime share of the transmission services of electricity.

Due to the lack of detailed data regarding the macro-indicators of insurance facilities, I determine the economic activities' shares from the total industry by using employment and paid salaries data. I calculate the share of maritime insurance from the non-life insurance by using an industry income statement (Finanssiala Ry, 2018), which separates income from the marine-, aviation-, and other transport insurance services from the total income. The maritime share of these operations was determined, again, by using the national statistics' input-output tables. Where data was not available Karvonen's expert estimation of the sector's maritime share was implemented.

As for the trade sector, some economic activities can be regarded fully maritime. For the rest of the economic activities, the activity's share of the total industry is again determined by using financial enterprise data, and structural business statistics (SBS) data. The maritime share of this industry is calculated by using data from the supply and usage-, and input-output tables of the national accounts.

4.2.3. Estimates for the Tourism Sector

I determine the coastal regions' shares from the tourism sector by extracting the macro-values of the NUTS-3 regions by using regional structural business statistics data (SBS). I then divide these regional values by the economic activities' aggregate national values and use them as a multiplier for the macro-indicators of the respective MEAs.

The coastal shares of each economic indicator are given in Table 3. The geographical classification of regions (NUTS) is used at the third level of detail, which is the most detailed geographical level. It should be noted that economic activities with no apparent connection to the blue economy are inexorably included in the economic analysis of the tourism sector, due to lack of more refined geographical classification and regional data.

Table 3. Coastal shares of the Tourism sector

COASTAL REGIONS' SHARE FROM NATIONAL VALUES					
NACE	**NUMBER OF ESTABLISHMENTS**	**NUMBER OF PERSONNEL**	**TURNOVER**	**VALUE ADDED IN PRODUCTION**	**SHARE ON AVERAGE**
55	63,7%	66,5%	69,8%	69,8%	67,45%
56	66,8%	71,5%	70,8%	72,0%	70,3%
79	72,7%	84,9%	89,9%	86,3%	83,45%
93	66,0%	67,8%	69,4%	-	67,7%

4.2.4. Estimates for the Public-, Education-, and Research & Development sector

No statistical data is available for the public-, education-, and research & development sector. Thus, for education-, public administration-, and safety activities, public expenditure data is utilized. However, for MEAs such as water treatment, -supply, and sewerage industry, SBS-data can be found and is therefore utilized.

Public expenditure data is presented and compiled in an aggregate form, thus estimates are needed regarding the navy and other public safety activities, as well as maritime related education. In order to make sense of the public sector's maritime share, first, I calculate the defense activities-, public order-, and safety activities sector's shares from the main industry using public expenditure data. Approximations of the economic activities' share from the aggregate values are based on the share of expenditure by category, in this case, defense and public order activities. I then divide this share by the total public corporation's expenditure data. These shares are roughly 2 percent and were used to determine the magnitude of turnover, value added and exports. The shares of sectorial employment from that of the whole industry were used in the estimation of employment.

Furthermore, in the case of public order and safety, the water rescue vehicles and – equipment's percentage from the entire rescue vehicle utensil was used to determine the possible maritime share of the industry, as a result of inadequate data. Due to the lack of data, the maritime share estimates of these categories are based on the proportion of

employment of the economic activities. The Navy's share of the defense industry's employment is approximately 11.7%, whereas the share of cadets and the share of water rescue vehicles, is slightly over 15%. To test the impact of these assumptions, I provide sensitivity analysis by adding lower and higher values to the proxies.

According to Statistics Finland, the public sector used nearly half of its environmental protection budget on water protection and sewerage services (Julkisen sektorin ympäristönsuojelumenot (SVT), 2014). Due to insufficient data, I apply this estimate to public environmental protection expenditure data from 2015, to determine the amount of public money spent on water-based environmental protection.

I calculate the maritime shares of research and development, as well as higher marine-linked education, by summarizing the sector's supply to marine industries and dividing it with the industry's total supply. I determine the industry share of higher education by using data from the national classification of education data regarding the type of education and the number of students. I then combine the number of students in higher education levels, and divide the sum by the total number of students in all education levels. The share of higher education was approximately 23%, but due to the generality of data, I apply lower and higher estimations for sensitivity analysis.

The different shares of the economic activities are presented in Table 4. The first industry shares are used to determine the sector's share from the total public expenditure data. The second industry shares presented in Table 4. indicate the estimated individual economic activity's (e.g. "defense activities"), share from the industry ("public order and safety"). Furthermore, the maritime share of the economic activity describes the marine related proportion of the activity, for example, the share of the Navy from the defense activities.

Table 4. Maritime shares of the Public sector – low, medium and high estimates

Public sector				
NACE	**MEA**	**Industry share, %**		**Maritime share, %**
E 36.00	Natural water; water treatment and supply services			100
E 37.00	Sewerage			100
G02	Defence activities	(L) 1	10	10
		(M) 2	11	11
		(H) 3	12	12
(year 2016) G03	Public order and safety activities	1	7	14

		2 3	8 9	15 16
(year 2015)	Environmental protection			45 50 55
M.72.00	Research and development	100 100 100		1 2,5 4,5
P.85.40	Higher education	15 23 30		3 5,7 8

5. The Economic Contribution of Blue Economy – A Sector-based Analysis

A sector-by-sector analysis of the economic contribution of blue economy is provided by presenting and analyzing the calculated macro-indicators and discussing their economic role in the national economy. Medium estimates are used to represent the sectors economic contribution.

5.1. Living resources

Overall, using data from 2014–2018 the living resources sector amounts to 981.6 million in turnover, employing over 2500 people. The total value added of the sector comes to 154.3 million euros. The total value of exports adds up to 157.4 million euros, from which the exports of fish and fish products for human and non-human consumption covers 148 million euros. The majority of the exports of the living resource sector go to Europe. (Fishery and game statistics (SVT), 2018.)

Table 5. Economic indicators - the Living resources sector

Living resources				
MEA	Turnover (€, Million)	Employment (FTE)	Value added (€, Million)	Exports (€, Million)
Aquaculture	88,444	365	20,400	-
Marine fishing	38,779	217	19,100	-
Freshwater fishing	15,011	105	7,944	-
Fish processing	353,342	767	44,300	148,000
Wholesale of fish	328,000	573	35,400	7,401
Retail sale of fish	158,000	559	27,200	1,999
Total	**981,576**	**2586**	**154,34352**	**157,4**

The turnover of the living resources sector comprises roughly 9.9% of the entire gross output of agriculture-, forestry-, and fishing industry and approximately 2.5% of the industry's total employment. The living resources sector's shares of the national figures are quite insignificant, less than 0.1%. However, the sector's value added per employment ratio is slightly larger than that of the aggregate sectors, indicating that the productivity of the living resources sector is somewhat better (Table 6.)

Table 6. Macro-indicator ratios - The living resources sector

Living resources					
(Unit: € millions, employees FTE)	TO/EMP	VA/EMP	EXP/EMP	VA/TO	EXP/TO
Aquaculture	0,24	0,06	-	0,28	-
Marine fishing	0,18	0,06	-	0,52	-
Freshwater fishing	0,14	0,08	-	0,52	-
Fish processing	0,46	0,59	-	0,14	-
Wholesale of fish	0,57	0,69	-	0,11	-
Retail sale of fish	0,28	0,45	-	0,17	-
Total	**0,38**	**0,06**	**0,06**	**0,16**	**0,16**

The most productive industries within the living resources sector are the wholesale of fish, fish processing, and retail sale of fish. The fishing industry has the best value added to turnover ratio, which is however slightly under the agriculture, forestry, and fishing industry's aggregate value of 0.53. The wholesale of fish produces the most turnover per employment, fish processing following second. (National accounts (SVT), 2018.)

The fishing industry alone employed around 323 people in 2017. The freshwater fishing industry's share from this was approximately 105 people, thus marine fishing covers approximately 67% of the industry's employment. The total turnover for the marine fishing industry was close to 39 million euros, whereas that of freshwater fishing was merely 15 million euros. In 2016, the marine fishing industry produced over 19 million in value added (Fishery & game statistics, (SVT) 2018).

As for aquaculture, the total turnover of food fish farming was over 88 million euros and the industry employed approximately 365 people. Year 2017, was the second year that the turnover for food fish production grew, even though the amount of produced fish for food has remained somewhat constant. The aquaculture industry produced value added for over 20 million euros in 2016. (Vesiviljely 2017 (SVT), 2018; Fishery and game statistics (SVT), 2018.)

In 2017, 79 million kilos of fish were processed in Finland by approximately 139 enterprises. The share of the domestic raw material of fish used in fish processing grew slightly from 2015, as opposed to the amount of imported raw fish material. The fish processing industry is the largest in the living resources sector, measured by employment of 767 full time workers in 2017, and turnover of 353 million euros. The share of value added in the sector was 44.3 million euros in 2016, decreasing slightly from 2014. (Kalajalosteiden tuotanto 2017 (SVT), 2018; Fishery and game statistics (SVT), 2018.)

Furthermore, the turnover of the fish wholesale industry was approximately 328 million euros, whereas that of the fish retail sale industry was 152.8 million euros. The wholesale of fish employed approximately 573 people compared to the retail industry's 559 full time workers (Yritykset toimialoittain (SVT), 2018). The value added for the wholesale industry was reportedly 35.4 million in 2016, retail industry falling behind with 27.2 million in added value (Fishery and game statistics (SVT), 2018).

5.2. Marine Industry

The Finnish Maritime Cluster consists of various economic activities and industries that can differ quite significantly from each other, but are connected at least indirectly through their expertise in maritime. The maritime cluster consists of up to 60 or 100 economic activities depending on the scope of the analysis. However, the most essential operators in the marine cluster are shipyards and marine transportation operators, ports and port operators, classification authorities, financial institutes, insurance companies, the public sector, marine construction, renewable marine energy, and the marine industry. All of the sectors mentioned above are large entities consisting of a number of different economic activities. (Karvonen, et al. 2016.)

As can be seen from Table 7. the medium estimate for the marine industry produces a total turnover of 8.2 billion euros for the marine industry, and results in an employment of over 26 000 people working full time. The total value added of the industry comes to nearly 3 billion euros, and the share of exports to 2.9 billion euros.

Table 7. Macro-indicators - The Marine industry

Medium estimate	**Turnover** (€, Billion)	**Employment** (FTE)	**Value added** (€, Billion)	**Exports** (€, Billion)
Ports	1,98	7141	0,67	0,098
Transportation	2,53	7387	0,74	1,31
Marine construction	3,11	10265	1,18	1,51

Energy	0,32	239	0,30	0,01
Insurance	0,0739	471	0,05	0,002
Trade	0,23	563	0,03	0,0014
Total:	**8,23**	**26066**	**2,96**	**2,93**

5.2.1. Ports, Transportation, and Marine Construction

The ports and shipping industries are considered some of the most essential operators within the Finnish maritime cluster. As can be seen from Table 8. the total turnover for these three sectors comes to 7.6 billion, and value-added to 2.6 billion euros. Further, a large part of the industries' wealth derives from exports, as their combined export value comes to 2.9 billion euros. The sectors employ roughly 24 800 people working full time. By comparing Tables 7. and 8. it becomes clear that the economic role of these three sectors is much more prominent than that of the energy-, insurance-, and trade sectors, as they cover more than 90% of the aggregate values shown in Table 7.

Table 8. Macro-indicators - Ports, Transportation and marine construction

Medium estimate	**Turnover** (€, Million)	**Employment** (FTE)	**Value added** (€, Million)	**Exports** (€, Million)
Ports	1980	7141	670	98
Transportation	2530	7387	740	1310
Marine construction	3110	10265	1180	1510
Total	**7620**	**24793**	**2590**	**2918**

Traditionally, the majority of the income of the ports derives from passenger-, cargo-, and ship payments, but an increasing trend in the industry is to develop different services around the port operations that create added value and sales, and increase port bound manufacturing and therefore increases customer base. (Karvonen, et al., 2016.) The combined turnover of the ports sector comes to nearly 2 billion euros and employment to 7141 persons, in 2017. The share of exports in the ports sector is roughly 98 million, and value-added 670 million euros. (Yritykset toimialoittain SVT, 2018.)

The core operations of the shipping sector are freight and passenger transportation, but typically, the shipping companies in Finland are specialized in a particular segment, such as ro-ro transportation (roll on-roll off), usually carrying large cargo or cars. Exports in the shipping industry are generally larger than imports, although in recent years the balance of current accounts has shifted. (Karvonen, et al., 2016) In 2017, the combined turnover of the transportation sector was around 2.5 billion euros and the industry

employed roughly 7387 people. Furthermore, the value added of the transportation sector comes to approximately 740 million, and the share of exports to 1.3 billion euros, as can be seen from Table 8.

Here the marine construction industry consists of economic activities that include the shipbuilding and -repairing industry, water construction, as well as industries that serve the off-shore and the marine construction industry. The sector's combined turnover is approximately 3 billion euros and it employs over 10 000 full time workers. The marine construction industry has a value-added of roughly 1.2 billion euros, and the value of the sector's exports comes to 1.5 billion euros.

The ports and transportation sectors cover around 19.2% of the transportation and storage industry's output, and roughly 8.2% of the industry's value added. From the industry employment, ports and water transportation sectors comprise of approximately 10%. Furthermore, the marine construction sector covers around 8.9% of the whole construction industry's output, 8.6% of the industry's value added, and approximately 5% of the employment. Compared to the manufacturing industry, the marine construction sector comprises only 2.8% of the industry output, 3.5% of the value added, and 3% of the employment.

The transportation sector has the best turnover to employment ratio of the three, whereas the marine construction sector has a slightly better productivity ratio compared to the ports and transportation sectors (Table 9.). The share of exports to turnover is the largest in the transportation sector. The marine construction sector generates the most value added per million euros of turnover followed by the ports sector. The marine construction produces slightly more value added from its turnover compared to the manufacturing industry (0.30), whereas the transportation and ports sector generate a little less than the transportation and storage sector (0.38). However, the ports and transportation sector both perform slightly better than the transportation and storage industry (0.06), measured by generated value added per employment.

Table 9. Macro-indicator ratios - Ports, transportation and marine construction

(Unit: € millions, employees FTE)	TO/EMP	VA/EMP	EXP/EMP	VA/TO	EXP/TO
Transportation	0,34	0,10	0,18	0,29	0,52
Ports	0,29	0,10	0,01	0,34	0,05
Marine Construction	0,30	0,11	0,15	0,38	0,49

5.2.2. Other sectors – Energy, Insurance, and Trade

The combined turnover for the energy-, marine insurance-, and trade sectors comes to more than 600 million euros, value added reaching nearly 400 million euros. The sector employs roughly 1300 people, indicating a good productivity ratio. The value of exports for these sectors is quite small, only around 3.5 million euros, which is not surprising for mainly service catering companies.

Table 10. Macro-indicators for the Energy, Insurance, and Trade sector

Marine industry				
	Turnover (€, Millions)	**Employment** (FTE)	**Value added** (€, Millions)	**Exports** (€, Millions)
Energy	320,850	239	299,740	0,0126
Insurance	73,920	471	47,050	2,100
Trade	223,870	563	27,190	1,430
Total (medium estimate)	**618,64**	**1273**	**373,98**	**3,5426**

In 2016, the total production of electricity with renewable resources, including liquors and wood-based fuels, was 44.7 GWh % from the total production of electricity. From this, the share of hydro- (23.6%) and windpower (4.6%) was approximately 28.2 GWh %. Compared to year 2015, electricity production with hydropower decreased by nearly 6%, in contrast to the share of wind power which increased by nearly 32 GWh %. (Sähkön ja lämmön tuotanto (SVT), 2016.)

In addition to the energy production sector, the transmission services for electricity are included in this sector classification. The total turnover of Finnish blue energy in 2017, was roughly 321 million euros. The industry employed around 239 persons, and created added value for nearly €300 million euros. The share of exports from the domestic energy production is small; thus the share of exports in blue energy was merely 12 600 euros.

The total estimated turnover for the marine insurance activities comes to nearly 74 million euros, whereas value added is estimated at 47 million euros. Marine-based employment in the industry is roughly 470 people working full-time. The total export value of the marine insurance industry is merely 2 million euros.

The last remaining segment of the marine industry is the trade sector. This sector consists of economic activities related to manufacturing of equipment for water-based activities, the sale of goods related to maritime, and other technical operations and services serving

the maritime industry. The combined turnover for these economic activities, based on data from 2017, is approximately 224 million euros. The sector employed around 563 people and it produced value-added up to 27 million euros. The share of imports in the industry was around 1.43 million euros.

Compared to the ports-, transportation-, and marine construction sectors, the share of the energy-, insurance-, and trade sectors from the national accounts are significantly smaller, less than 0,0% overlooking the energy sector, the share of which is roughly 0,13% from the national GDP.

Furthermore, the marine energy sector's share of the total output of the energy supply industry is roughly 3.6%, and slightly over 7% of the industry value added. It should be noted that the productivity ratios of the marine energy sector are significantly higher compared to any other MEA, indicating that the sector produces proportionately a great deal of value added. Furthermore, the value added to turnover share of marine energy is twice of that of the energy supply industry (0.46).

Measured by the productivity of labor ratio (Table 11.), the marine insurance sector performs somewhat more poorly compared to the financial and insurance activities industry. However, the value added to turnover ratio of the marine insurance industry is 0.08 units more than that of the aggregate industry. The share of the marine insurance sector from the aggregate industry output, is roughly 0.6%. This share is significantly less than the estimate provided by Karvonen (personal communication via email, 9.3.2018) which could be due to insufficient data regarding maritime insurance activities.

Finally, the marine trade sector, the smallest of the marine industry sectors, covers only 0.67% of the large trade industry's output. The marine trade's value added to employment ratio is in line with the industry's productivity ratio of 0.6. The marine trade sector performs slightly better than the industry (0.12) if measured by the turnover to employment ratio. Furthermore, the marine trade sector falls behind the trade industry when the value added to turnover ratios are compared. Over 50% of the trade industry's output is turned into value added, whereas the respective value for the marine trade is only 12%.

Table 11. Macro-indicator ratios for the energy-, insurance-, and trade sectors

(Unit: € millions, employees FTE)	TO/EMP	VA/EMP	EXP/EMP	VA/TO	EXP/TO
Energy	1,34	1,25	0,00	0,93	0,00
Insurance	0,16	0,10	0,00	0,64	0,03
Trade	0,40	0,05	0,00	0,12	0,01

5.3. Tourism

The national statistics of Finland and Visit Finland monitor the economic development of the tourism sector and tourism accounts. According to the tourism account report, the total expenditure of tourism in 2016 was approximately 13.8 billion euros. From this, the share of foreign travelers is about 26%, which is approximately 3.6 billion euros. The report estimates the tourism sector's value added at 4.6 billion euros, making it comparable to the agriculture, forestry and fishing sector in relative size.

The share of blue tourism from the entire tourism sector's turnover is approximately 28.9%, whereas the share of the industry's value added is roughly 11%, and employment 14.5%. (Business Finland, Visit Finland, 2018.) The blue tourism sector employs somewhat 20 000 people, and produces a turnover of nearly 3.9 billion euros. The value added of the sector comes to approximately 465 million euros, and around 341 million euros derive from inbound tourism. (Table 12.)

Table 12. Macro-indicators for the blue tourism sector

Tourism				
MEA	**Turnover** (€, Millions)	**Employment** (FTE)	**Value added** (€, Millions)	**Inbound tourism demand** (€, Millions)
Acommodation	1141,677	6240	322,946	144,363
Food & beverage serving activities	1483,578	10971	121,601	118,344
Travel agency and tour operator services	1111,293	1555	19,105	41,232
Sports activities	42,138	454	0,4107	-
Amusement and recreation services	121,103	921	1,1315	36,720
Total	**3899,8**	**20140**	**465,2**	**340,7**

The blue tourism sector comprises 0.21% of the national GDP at current prices, whereas the entire tourism industry covers around 2% of the national GDP. Furthermore, the blue tourism sector's share of the national GVA is approximately 0.24%, compared to the 2.4% share of the tourism industry. The share of the tourism industry's turnover from the

national output, is approximately 3.3%, when in turn, the share of blue tourism's turnover is close to one percent.

Regionally, Åland has the highest share of tourism from the national GDP. (Business Finland, Visit Finland, 2018.) The coastal regions' share from the economic indicators of the entire nation can be seen from Table 3. The shares of coastal areas of each economic activity are quite prominent and inevitably include economic activities that do not directly benefit from the marine-, or coastal areas.

As can be seen from Table 13., the blue tourism sector has a slightly higher turnover to employment ratio compared to that of the tourism industry (0.1). However, the blue tourism sector falls slightly behind in the productivity ratio of 0.03 of the tourism industry. This can indicate that the economic activities left outside the analysis of this study, produce a slightly better value added to employment ratio possibly due to a lower workforce intensity. Furthermore, the value added to turnover ratio of the blue tourism sector is somewhat lower than that of the industry's, which is approximately 0.33.

Table 13. Macro-indicator ratios for the blue tourism sector

(Unit: € millions, employees FTE)	TO/EMP	VA/EMP	EXP/EMP	VA/TO	EXP/TO
Acommodation	0,18	0,05	0,02	0,28	0,13
Food & beverage serving activities	0,14	0,01	0,01	0,08	0,08
Travel agency and tour operator services	0,71	0,01	0,03	0,02	0,04
Sports activities	0,09	0,0009	-	0,01	-
Amusement and recreation services	0,13	0,0012	0,04	0,01	0,30
Total:	**0,202**	**0,025**	**0,017**	**0,123**	**0,085**

5.4. The Public sector

Based on the medium estimate, the public sector employed approximately 5943 people, and created value added worth roughly half-a-billion euros. The combined turnover and public expenses spent on the economic activities of the public sector, come to 2.3 billion euros.

Table 14. Macro-indicators for the Public sector

Public sector				
MEA	**Turnover/ Public expenditure** (€, Millions)	**Employment** (FTE)	**Value added** (€, Millions)	**Export** (€, Millions)

Natural water; water treatment and supply services	1018,483	2606	396,000	42,547
Sewerage	174,177	565	116,776	27,598
Defence activities	265,771	1391,5	0,724	0,189
Public order and safety activities	362,415	1380	0,987	0,258
Environmental protection	490,500	-	-	-
Total	2311,346	5942,5	514,486384	70,592756
(medium estimate)	**2311,35**	**5943**	**514,49**	**70,59**

The public sector's share from the entire public administration industry output, is approximately 11%. Employment of the marine-based public sector activities covers approximately 3.6% of the industry's total employment, and around 4.7% of its value added. Furthermore, the sector comprises 0.23% of the national GDP and 0.27% of the GVA. The public sector's share of the total national output is slightly over half a percent, and its share from the national employment is approximately 0.2%.

In Finland, water treatment, -supply, and sewerage facilities are usually either private joint-stock companies or municipality-owned companies. Water treatment facilities need a municipal approval for operating, and several laws regarding water safety and quality regulate the industry. In 2017, the combined turnover of the industries was roughly 1.19 billion euros and it employed over 3000 people. Value-added for these sectors comes to approximately half a billion euros.

The Finnish Navy and other marine safety activities' share from the total public expenditure, is roughly 0.29 to 0.96 billion euros, based on data from 2015. However, the navy is updating its squadron by 2020, which means that the sector is experiencing an increase in its budget. In 2018, the Ministry of Defense admitted 1.2 billion euros for the Navy's squadron project. An estimate for the entire defense sector's budget for 2019 is over three billion euros, and an additional six-million-euro increase is put forward to hire more employees. (Räisänen, 2018.) Currently, the navy is evaluated to employ approximately 1400 people, an estimate that matches the derived results presented here. (Puolustusvoimat: Pääesikunnan viestintäosasto, 2018.)

Compared to the macro-indicator ratios of the public administration industry, the marine-based public sector surpasses the industry ratios of value added to employment (0.07) and turnover to employment (0.13), indicating a marginal difference between the productivities of these two sectors. (Table 15.)

Table 15. Macro-indicator ratios of the Public sector

Public sector					
MEA	**TO/EMP**	**VA/EMP**	**EXP/EMP**	**VA/TO**	**EXP/TO**
Natural water; water treatment and supply services	0,39	0,15	0,0163	0,3888	0,0418
Sewerage	0,31	0,21	0,0488	0,6704	0,1584
Defence activities	0,19	0,0005	0,0001	0,0027	0,0007
Public order and safety activities	0,26	0,0007	0,0002	0,0027	0,0007
Environmental protection	-	-	-	-	-
Total (medium estimate)	0,39	0,09	0,01	0,22	0,03

5.5. The Education-, and R&D sector

In the analysis conducted here, the marine education and -R&D sector employs approximately 2244 people, and produces a combined output of 207.5 million euros. The value added for the sector is approximately 174.5 million euros, whereas the share of exports in the industry is quite low, merely 12.5 million euros. (Table 16.)

Table 16. Macro-indicators for the education and R&D sector

Education, R&D				
MEA	**Turnover/ Output** (€, Million)	**Employment** (FTE)	**Value added** (€ Million)	**Exports** (€ Million)
Research and development	22,005	110,05	40,150	12,348
Higher education	185,533	2134,308	134,404	0,152
Total	207,537	2244,358	174,554	12,4999
(medium estimate)	**207,54**	**2244**	**174,55**	**12,5**

The marine education, research and development sector's share from the education industry's employment, is roughly 1.4%. The turnover share of the sector comes to approximately 1.5%, and the value added share to 1.7%. As to the macro-indicator ratios, presented in Table 17., the sector slightly exceeds the education industry ratios of 0.72 and 0.067 of value added to turnover, and value added to employment. The turnover to employment ratios of the industry and the sector are both approximately 0.09.

Table 17. Macro-indicator ratios of the education and R&D sector

Education, R&D					
(Unit: € millions, employees FTE)	**TO/EMP**	**VA/EMP**	**EXP/EMP**	**VA/TO**	**EXP/TO**
Research and development	0,2000	0,3648	0,1122	1,8246	0,5611

Higher education	0,0869	0,0630	0,0001	0,7244	0,0008
Total Medium estimate	**0,092**	**0,078**	**0,006**	**0,841**	**0,0602**

Put into the perspective of the national values of GDP, GVA and employment, the marine education-, research-, and development sector is somewhat marginal, contributing less than 0.1% to each macro-indicator. However, the education sector, as can be expected, produces a great deal of value added in relation to turnover produced and employees used.

6. An economic overview of the blue economy

Comparing the blue economy sector to other relevant sectors in the Finnish national economy, provides a more comprehensive overview of the sectors economic role. The relative national account proportions of the blue economy sectors, as well as other economic sectors, are analyzed in this section. Additionally, international comparison of the structural differences of the blue economy sector is provided.

6.1. The role of blue economy in the Finnish economy

The six sectors of the Finnish blue economy generated in total a turnover of 15.3 billion euros, constituting roughly 2% of the national GDP based on the medium estimate. The sector created 4 billion euros in value added, which accounts for over 2% of the national GVA. Employment of the blue economy comes to 55 thousand people, which is 2.2% of the national employment of Finland. The share of exports from the national total is roughly 4.1%, and 3.5 billion euros. Furthermore, the total turnover of the blue economy sector covers over 3.5% of the national output. (Table 18. and 19.)

Table 18 Blue economy sector - economic indicators in total

Industry	Turnover (€, Billions)	Employment (FTE)	Value added (€, Billions)	Exports (€, Billions)
Living resources	0,916	2596	0,154	0,148
Marine Industry (low)	7,87	24785	2,83	2,91
Marine Industry (medium)	8,23	26066	2,96	2,93
Marine Industry (high)	8,6	27347	3,09	2,95
Marine industry (Pritzztech)	13,105	42720	4,61	4,824
Tourism	3,9	20 140	0,47	0,341
Public sector, education, R&D (low)	1,9	5448	0,514	0,07
Public sector, education, R&D (medium)	2,3	5943	0,514	0,071
Public sector, education, R&D (high)	2,7	6483	0,516	0,071
Total (medium)	**15,346**	**54 745**	**4,098**	**3,49**

Total (low)	14,586	52 969	3,968	3,47
Total (high)	16,116	56 566	4,23	3,51
Total (prizztech & medium estimates)	20,221	71 399	5,748	5,384

Table 19. The share of blue economy sectors from the national economy of Finland

The share of blue economy from GDP,GVA, Employment, and Exports 2017 (low, medium, high & Prizztech (2016) estimates)	
GDP	1,8-2,6 %
Employment	2-2,7 %
Value added	2,0-3,0 %
Exports	4,0-6,2 %
Output	3,5-4,9 %
Reference by: National Accounts, Table 007 & 008, (SVT) 2018	

By looking at the macro-indicators (Table 18.) we can see the differences in the relative sizes of each sector. Maritime industry is the largest blue economy sector in Finland, measured by value added, exports and employment. However, it should be noted that the maritime cluster comprises of several rather significant sub-sectors, such as maritime construction, ports, and transportation; therefore, the significance of the tourism sector in terms of employment and national output should not be overlooked.

The relative importance of the marine cluster to the national economy, has been taken into notice in the drafting of the Finnish national marine policy. The marine cluster is seen as a possible solution for sustainability issues in the industry, through energy-, and material efficiency, as well as renewable fuels and digitalization. The future development of the marine cluster is dependent on global markets; thus the national marine policy aims at making Finland a front-runner and an essential influencer in the marine industry by enhancing marine know-how, research, and education. (Itämeri- ja meripolitiikan ohjausryhmä, 2018.)

Moreover, Figures 1.–4. show the macro-indicator values of the blue economy sector by each three-point estimation. Similarly, to the national account shares (Table 21.), these figures provide insight into the different magnitudes of each blue economy sector, and estimate. As can be seen from the charts, the estimates do not vary significantly in value and the relative sizes of the sectors stay quite constant apart from the relative size of the public sector.

When the marine industry sector is split into sub- sectors, the marine construction sector becomes the largest blue economy sector measured by the lowest estimate of value added, followed by transportation, ports, and public sector, then tourism and living resources. In

terms of turnover, tourism is the largest sector, second the marine construction sector, and third the transportation-, and the public sector. The marine construction- and transportation sectors are the most significant sectors measured by exports.

Figure 1 Blue economy sectors by turnover, value added, and exports – Low estimate

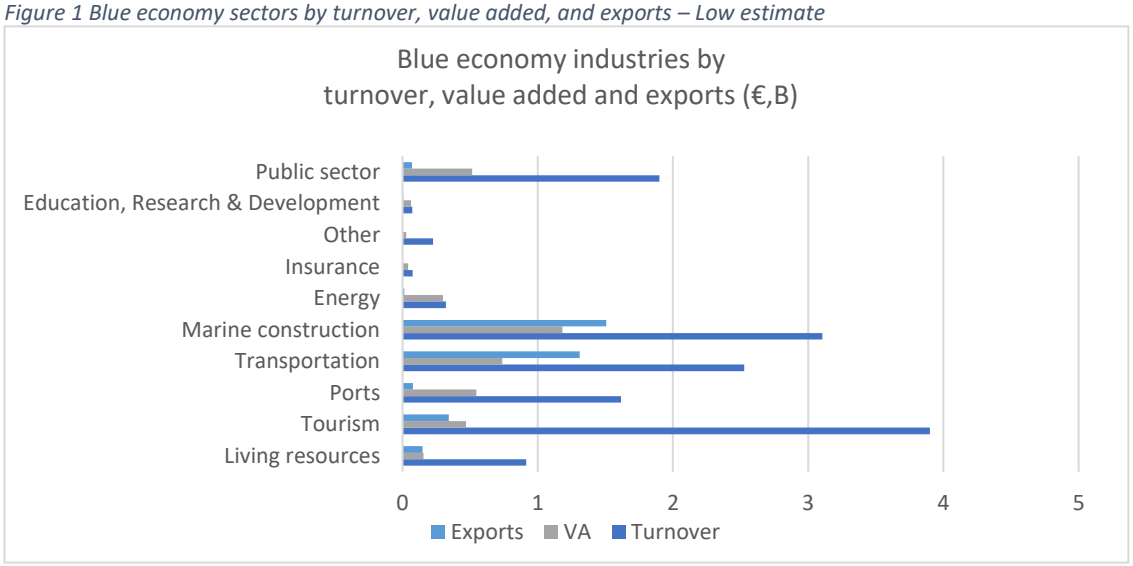


Figure 2 Blue economy sectors by turnover, value added, and exports – Medium estimate

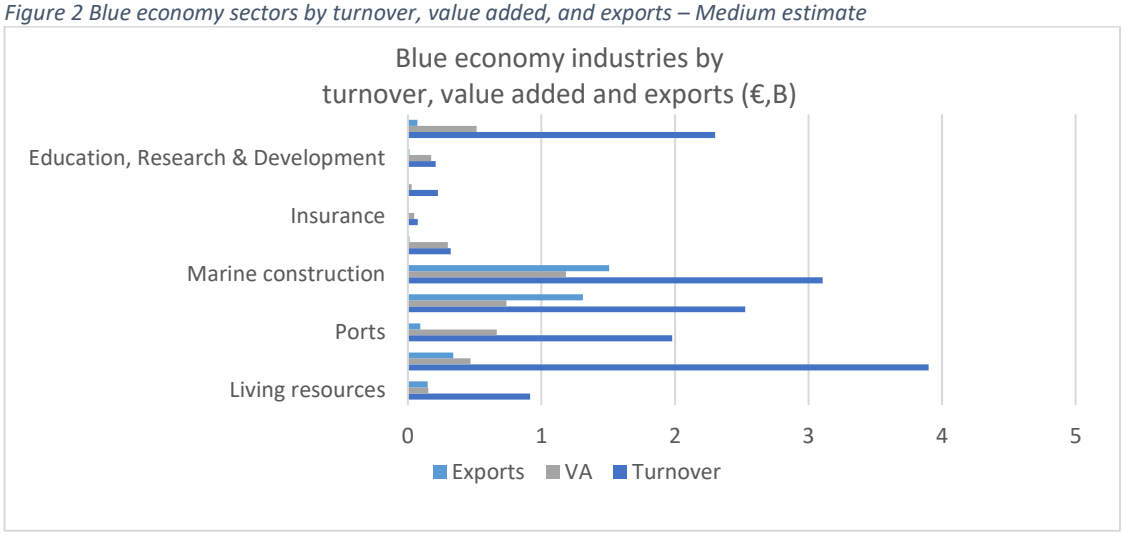
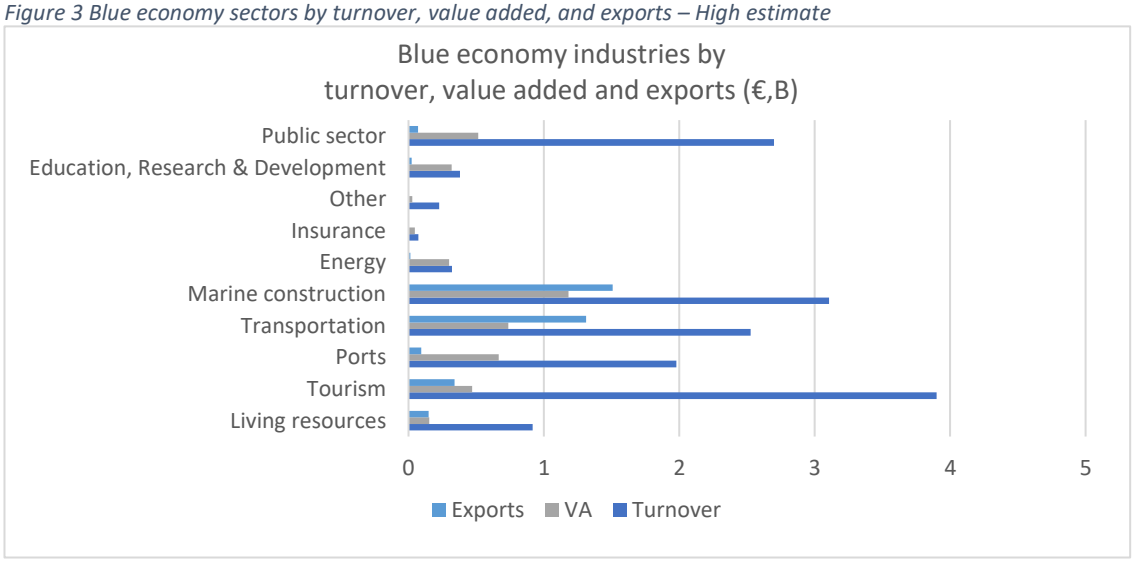


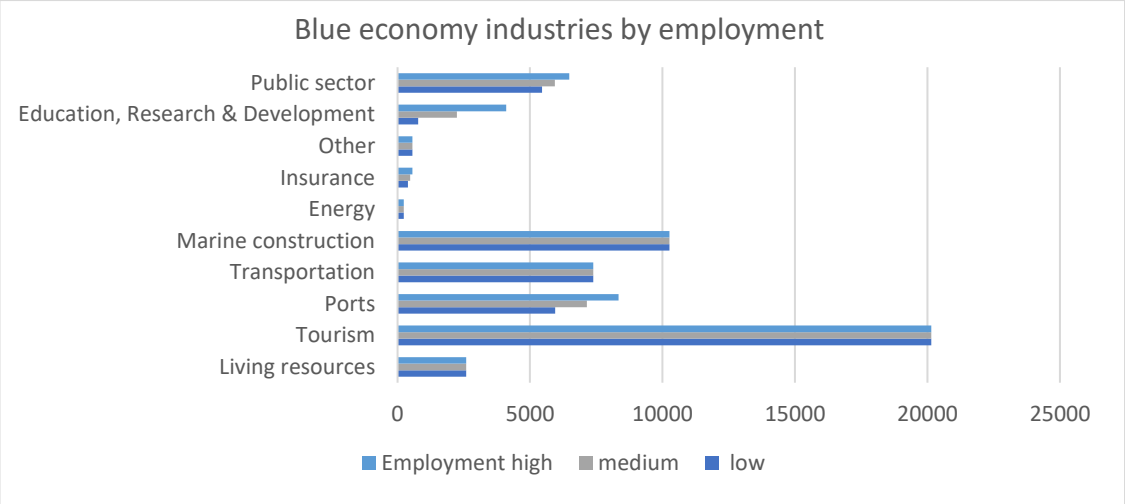
Figure 3 Blue economy sectors by turnover, value added, and exports – High estimate



The high estimate (Figure 3.) clearly increases the relative size of the public sector in terms of turnover, making the public sector's relative size compared to the other sectors is surprisingly prominent. This is most likely due to the significant size of the natural water supply-, treatment, and sewerage activities, as well as the large share of water-related environmental protection activities included in the analysis. Furthermore, the increased budget for the navy squadron may momentarily affect the public sector's relative proportion.

Measured by employment, tourism is the largest of the blue economy sectors. The second largest sector in terms of employment is the marine construction sector. (Figure 4.)

Figure 4 Employment in the blue economy sectors based on high-, medium-, and low estimates



The sector-specific macro-indicator ratios presented in the analysis in section 5. are assembled in Table 20. By looking at these macro-indicator ratios, the blue energy sector creates the most value added and turnover in relation to employment. The renewable energy sector is not very labor intensive, and most of the industry costs stem from the initial outlay investments and building costs, thus the sector’s high value-added creation is intuitive. As to the turnover-employment ratios, the public sector has the second highest ratio, following the living resources sector. The transportation sector has the highest rate in the share of exports to employment and -turnover ratios, indicating that a relatively large share of the industry’s income comes from international trade. The marine construction sector has the second highest rates in the export ratios.

Table 20. Total macro-indicator ratios for all blue economy sectors (medium estimates)

	TO/EMP	VA/EMP	EXP/EMP	VA/TO	EXP/TO
Living resources	0,38	0,06	0,06	0,16	0,16
Energy	1,34	1,25	0,00	0,93	0,00
Insurance	0,16	0,10	0,00	0,64	0,03
Trade	0,40	0,05	0,00	0,12	0,01
Transportation	0,34	0,10	0,18	0,29	0,52
Ports	0,29	0,10	0,01	0,34	0,05
Marine Construction	0,30	0,11	0,15	0,38	0,49
Tourism	0,20	0,03	0,02	0,12	0,09
Public sector	0,39	0,087	0,012	0,22	0,031
Education, R&D	0,09	0,08	0,01	0,84	0,06

If we compare the individual sectors' national account shares (Table 21.) it is clear that the marine construction sector has the largest share from the national GDP, followed by the transportation-, and the ports sector. Additionally, the marine construction sector has the largest national value-added share from the blue economy sectors. However, if measured by the share from the national output, the tourism sector is by far the largest blue economy sector. Further, the blue tourism sector has the largest share from the national employment.

Table 21. National account shares- the living resources sector

Shares from the national accounts	
Living resources	
GDP (market prices)	**0,07 %**
GVA (basic prices)	**0,08 %**
Output (basic prices)	**0,2 %**
Employment	**0,1 %**
Ports	
GDP (market prices)	**0,3 %**
GVA (basic prices)	**0,4 %**
Output (basic prices)	**0,5 %**
Employment	**0,3 %**
Transportation	
GDP (market prices)	**0,3 %**
GVA (basic prices)	**0,4 %**
Output (basic prices)	**0,6 %**
Employment	**0.3 %**
Marine construction	
GDP (market prices)	**0,5 %**
GVA (basic prices)	**0,6 %**
Output (basic prices)	**0,8 %**
Employment	**0,4 %**
Blue energy	
GDP (market prices)	**0,1 %**
GVA (basic prices)	**0,2 %**
Output (basic prices)	**0,08 %**
Employment	**0,01 %**
Marine insurance	
GDP (market prices)	**0,02 %**
GVA (basic prices)	**0,02 %**

Output (basic prices)	**0,02 %**
Employment	**0,02 %**
Marine trade	
GDP (market prices)	**0,01 %**
GVA (basic prices)	**0,0 1%**
Output (basic prices)	**0,05 %**
Employment	**0,02 %**
Tourism	
GDP (market prices)	**0,4 %**
GVA (basic prices)	**0,4 %**
Output (basic prices)	**1,2 %**
Employment	**1,0 %**
Public sector	
GDP (market prices)	**0,2 %**
GVA (basic prices)	**0,3 %**
Output (basic prices)	**0,6 %**
Employment	**0,2 %**
Education, R&D	
GDP (market prices)	**0,08 %**
GVA (basic prices)	**0,09 %**
Output (basic prices)	**0,05 %**
Employment	**0,09 %**
Reference by: Statistics Finland, National Accounts; Table 007, (SVT(2018); National Accounts 2008-2017*, (SVT) 2018	

Here we turn to the comparison of blue economy to other sectors of the Finnish economy. In order to perceive an understanding of this comparison, the value added shares of different industries from the national GVA and employment rates, are compared. Table 22. shows the national shares of the main national account industries value added and employment.

Table 22. National shares of all industries

Industry	VA Share, %	EMP Share, %
Agriculture	0,6 %	3,2 %
Forestry	2,0 %	0,9 %
Hunting & Fishing	0,1 %	0,1 %
Mining & Quarrying	0,4 %	0,3 %
Manufacturing	17,6 %	13,3 %
Forest industry	2,4 %	1,6 %
Metal industry	9,5 %	7,1 %
Energy supply	2,1 %	0,5 %
Water supply and waste management	1,0 %	0,5 %
Construction	7,1 %	8,1 %
Trade	9,1 %	11,4 %
Transportation and storage	4,8 %	5,7 %
Hotels & restaurants	1,8 %	3,4 %
Information & communication	5,8 %	4,2 %
Financial and insurance activities	2,9 %	1,7 %

Real estate activities	12,7 %	1,0 %
Professional, scientific & technical activities	5,2 %	6,0 %
Administrative & support service activities	3,5 %	5,8 %
Public administration & social security	5,7 %	6,5 %
Education	5,2 %	6,3 %
Human health and social work activities	9,4 %	15,6 %
Arts, entertainment & recreation	1,3 %	2,0 %
Other services	1,6 %	2,9 %
Blue economy	2,1 %	2,07%
Reference by: Statistics Finland: National Accounts, Table 007 &008 (SVT) ,2018		

Figure 5. shows these GVA-shares at basic prices. Forestry accounts for roughly 2% from the national GVA, whereas the forest industry (including paper and woodwork) account for 2.4% of the national GVA. The blue economy sector is thus slightly larger than forestry and possibly larger (high estimate) than the forest industry, covering 2-3% of the national GVA. The metal- and construction industries are significant at the national scale measured by value-added, as is their share in the marine industry.

Measured by employment, the blue economy's proportion from the national employment is approximately 2-2.7%, which is more than the share of forestry and forest industry, but slightly less than that of agriculture. The proportion of the trade industry from the national employment is roughly 11%; thus, it is a significant employer. Within the blue economy, the trade sector's input is not as prominent. The industry shares from the national employment can be seen from Figure 6.

Figure 5. The share of industries value added from the total national value added

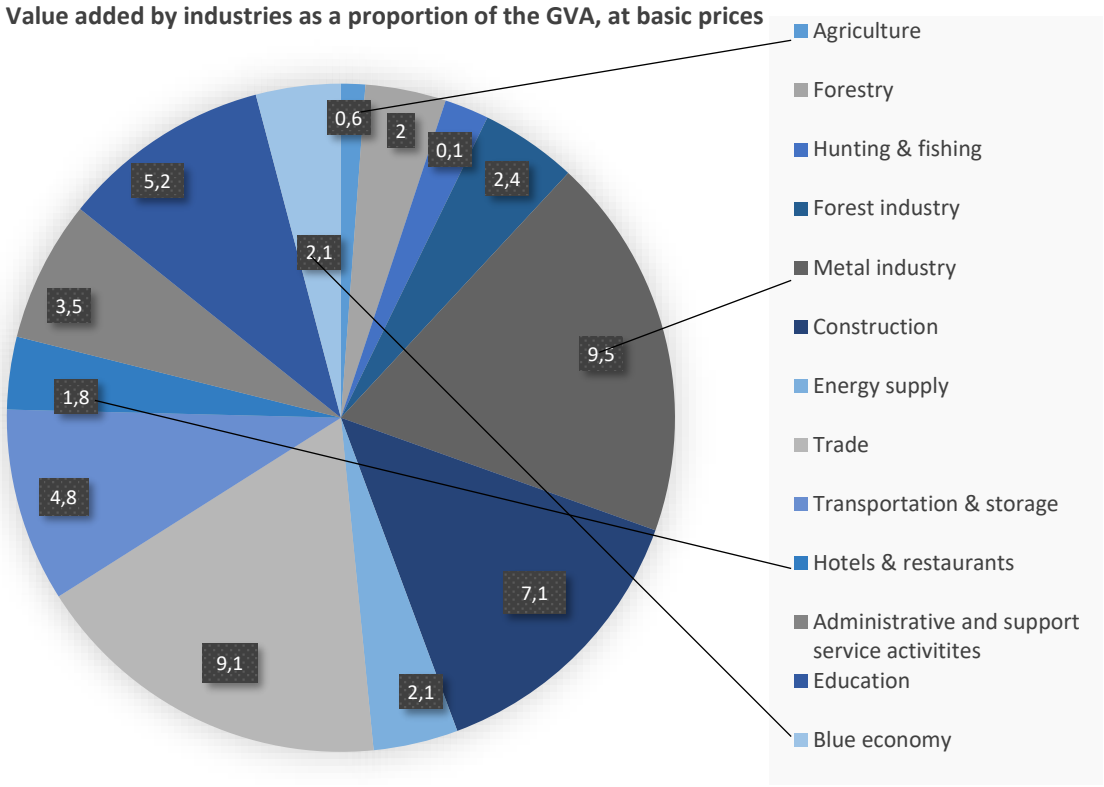
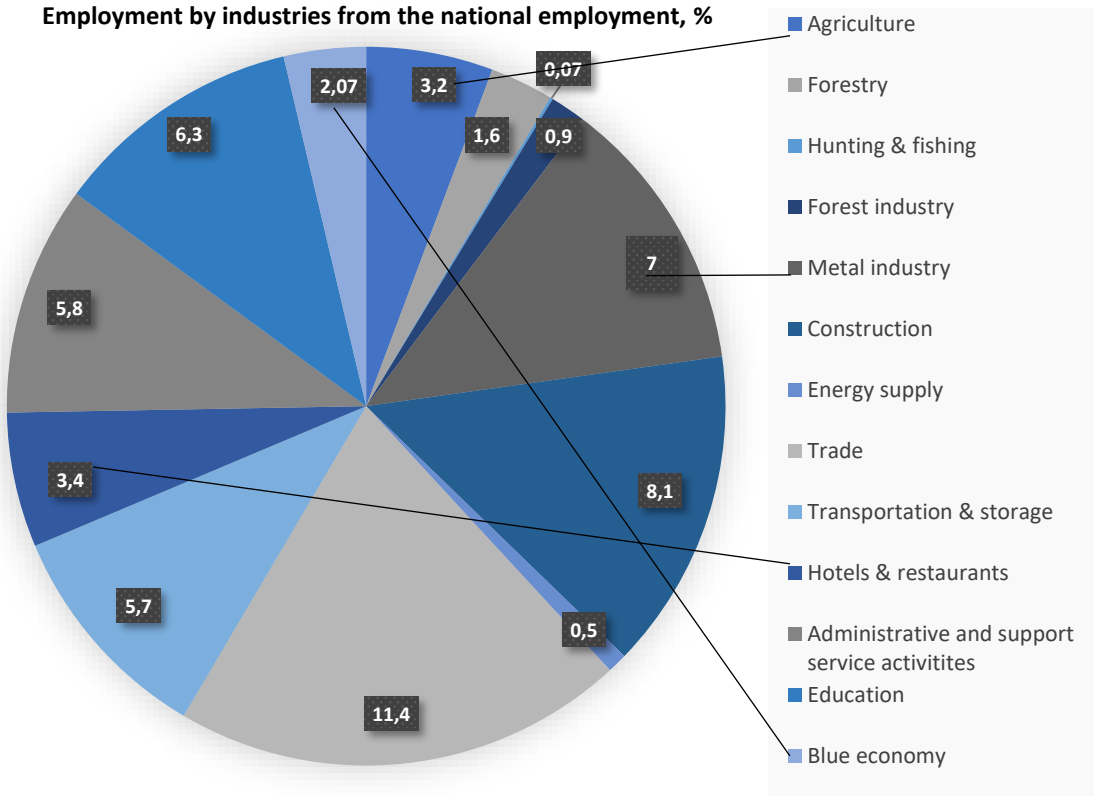


Figure 6. The share of industries employment from the total national employment



6.2. International comparison of the blue economy sectors

In a recent report by the EU's Maritime Affairs and Fisheries (Directorate - General for Maritime Affairs and Fisheries, 2018), a definition for the blue economy sectors and maritime economic activities is provided. Additionally, the value added and employment of these sectors are calculated for some EU member states.

The selection of economic activities is somewhat different from the one presented in this thesis, in fact the scope of the EU blue economy report is narrower if compared by the amount of maritime economic activities. Public sector, as well as the education-, research and development sector is left out of the economic analysis of the EU report, due to data limitations. Most of the economic activities included in the economic analysis of the EU report are entirely maritime. Additionally, the estimations for partially maritime activities are assumed to be 50%, and double counting occurs due to the inclusion of water transportation in the transportation-, as well as the tourism sector. Furthermore, the tourism sector consists of transportation activities that cannot be regarded as marine-linked, but are included in the calculations due to their coastal proximity. (Directorate - General for Maritime Affairs and Fisheries, 2018.)

Based on the sectoral classification established in the report by Maritime Affairs and Fisheries (2018), the total generated value-added of the blue economy sector is 2.6 billion euros. When this approach is applied to the calculations produced in this thesis, the value added for the sector comes to approximately 2.5 billion euros – half of the value added measured by the lowest estimate based on the selection of MEAs presented in this thesis, which highlights the difference of the scope between the studies. A regional comparison using the indicators conducted by the Maritime Affairs and Fisheries is provided below.

As can be seen from Tables 23. and 24. the largest blue economy sector of Finland, is tourism, followed by the transportation-, ports-, and the shipbuilding sector (Maritime Affairs and Fisheries, 2018). In contrast, based on the calculations conducted for this thesis, yet following the same classification of MEAs of the EU blue economy report, the third largest sector is shipbuilding, the ports sector ranking in fourth place.

In the case of Estonia, the largest sector by GVA is tourism. The second largest sector is ports, warehousing and the construction of water projects, followed by shipbuilding. Even though the combined value added of the blue economy sector of Estonia is significantly

lower than that of Finland, its share from the national GVA is nearly 4%, whereas for Finland that share is under 1.5%. For Sweden, tourism is again the largest sector, followed by the transportation sector. The transportation sector of Sweden is significantly larger than that of Finland in terms of generated value added.

Interestingly, the living resources sector is the third largest blue economy sector in Sweden measured by value added. For Denmark, the largest blue economy sectors by value-added, are the transportation-, and the oil & gas sector, tourism ranking third.

Table 23. Regional comparison of blue economy sectors - GVA, billion euros

GVA (€, Billions)	**Finland**	**Sweden**	**Estonia**	**Denmark**	**Germany**	**Spain**	**France**	**UK**
Tourism	1	3,025	0,367	2,7	4,066	17,5	9,56	7,89
Transportation	0,75	0,943	0,0508	4,3	5,856	0,586	1,959	3,96
Shipbuilding	0,283	0,278	0,06	0,192	1,24	0,87	1,827	3
Ports, warehousing, water projects	0,346	0,333	0,1945	0,593	2,572	0,902	1,484	4,03
Living resources	0,173	0,407	0,0455	0,82	2,12	3,235	2,738	2,55
Oil & gas	-	-	-	4,1	0,716	0,0988	0,148	17,44
Total:	2,552	4,986	0,7178	12,705	16,57	23,1918	17,716	38,87
GVA share, %	1,38	1,2	3,96	5,31	0,59	2,29	0,9	1,82
Reference by: Directorate - General for Maritime Affairs and Fisheries, 2018								

Table 24. Regional comparison of blue economy secyots - Employment

Employment	**Finland**	**Sweden**	**Estonia**	**Denmark**	**Germany**	**Spain**	**France**	**UK**
Tourism	19100	56700	17800	43400	131700	530100	154800	220600
Transportation	8800	13400	800	23000	28100	7200	17600	15900
Shipbuilding	6300	4600	2400	3000	26000	20800	28200	39400
Ports, warehousing, water projects	3600	3800	2500	5400	34900	17600	21300	36400
Living resources	5100	7700	4400	8600	41700	114800	56600	41400
Oil & gas	-	-	-	2600	5600	500	500	33400
Total:	42900	86200	27900	86000	268000	691000	279000	387100
Employment share, %	1,8	1,8	4,57	3,13	0,67	3,8	1,09	1,32
Reference by: Directorate - General for Maritime Affairs and Fisheries, 2018								

By looking at Table 23. it can be seen that for both France and Spain, tourism is again the largest blue economy sector measured by value added. The second largest sector for these countries is the living resources sector, whereas for Finland that is the smallest sector, since energy production is not defined as an individual sector in this definition of MEAs.

For Germany, the largest blue economy sector is the transportation sector, followed by tourism. In the case of the United Kingdom, the largest blue economy sector, measured by value added, is the oil and gas sector, which produces nearly twice as much value added as the tourism sector. (Directorate - General for Maritime Affairs and Fisheries, 2018.)

The United Kingdom has the largest blue economy sector measured by GVA mainly due to the scope of the oil and gas industry. Spain has the second largest blue economy sector, followed by France. Finland, on the other hand, has the second smallest blue economy

sector after Estonia. The difference between the largest and the smallest blue economies is quite significant, the largest contributing approximately 39 billion euros in value-added and the smallest less than one billion euros. Measured by employment, Spain has the largest blue economy sector with nearly 700 000 people employed (Table 24.), followed by the United Kingdom and France.

Furthermore, when the shares of the blue economy sector are calculated from the national GVA, Denmark has the most significant blue economy sector with over 5% share, followed by Estonia with 3.9%, and Spain with 2.3%. If the share of the sectors' employment is scrutinized, the largest blue economy is that of Estonia's (4.6%), followed by Spain (3.8%), and Denmark (3.1%). (Directorate - General for Maritime Affairs and Fisheries, 2018.)

Figure 7 Blue economy sectors by country, measured by GVA in billions of euros.

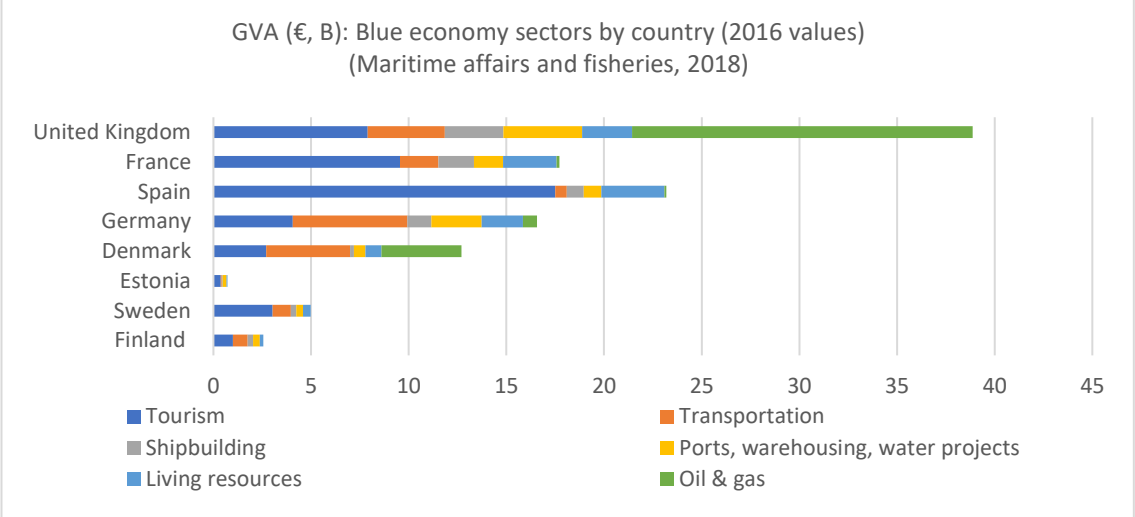
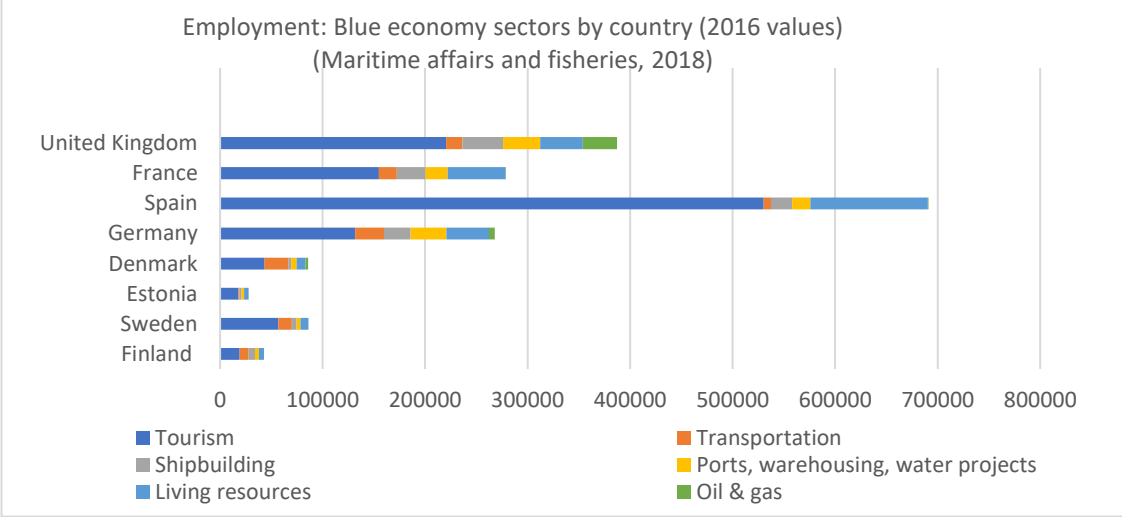


Figure 8 Blue economy sectors by country, measured by employment.



7. Discussion – Blue bio-economy sectors in Finland

In this section, I discuss the economic contribution of the largest blue bio-economy sectors in Finland. It is a central focal point of the Finnish national marine policy to utilize and manage the oceans and seas in an environmentally sustainable way, following the principles of blue growth. Tourism, renewable energy, and aquaculture are seen as potential drivers for this kind of sustainable economic growth. For instance, Finnish sea-based energy is considered as an essential sector to develop and scale in order to further the transition to low carbon energy production. In regards to climate change and global-, as well as national food security, aquaculture is seen as an important industry for new business and job creation. Furthermore, tourism has a significant economic role in Finland, as in most EU member states. In Finland, especially tourism that benefits from the sea, coast, archipelago, lakes, and rivers, is considered to have substantial growth potential and generate more wealth in the near future. (Itämeri- ja meripolitiikan ohjausryhmä, 2018.)

The total turnover generated by these blue bio-economy sectors is roughly 6 billion euros. The sectors create value added worth 1.3 billion euros and employ nearly 28000 people. Total generated exports for the tourism-, living resources-, and the blue energy sector comes to roughly 1 billion euros.

Table 25. Economic indicators - tourism (including passenger water transportation), living resources, and energy

	Turnover (€, Billion)	Value Added (€, Billion)	Exports (€, Billion)	Employment (FTE)
Tourism (water transportation)	5,1	0,805	0,926	25085
Living resources	0,916	0,154	0,148	2596
Energy	0,321	0,3	0,013	239
Total	6,337	1,259	1,087	27920

From the national perspective, the tourism-, living resources-, and energy sectors combined value added covers around 0.56 % of the national GDP, and nearly 0.7% of the GVA, thus assimilating to agriculture on the national level. Their total share from the national exports is nearly 1.3%, and 1.1% of the national employment. On the national level, the three sectors employ more people than the forest industry, but less than forestry or agriculture. (Table 26.)

Table 26. The share of tourism-, living resources-, and the energy sector from national indicators

	Tourism	Energy	Living resources	Total:
Share from GDP, %	0,35962706	0,13402251	0,0687982	0,56 %
Share from national value added, %	0,416520065	0,15522487	0,0798598	0,65 %
Share from national exports, %	1,073623188	0,01460870	0,1715942	1,26 %
Share from national employment, %	0,985580701	0,00939022	0,1019959	1,10 %
Share from national output %	1,23	0,078	0,22	1,5 %

As to studies estimating the size of the blue economy sector, different transportation methods are generally regarded as part of the tourism sector, as these economic activities are an integral link between different tourism activities. In this section, "passenger water transportation activities" are included in the tourism sector calculations. (Directorate - General for Maritime Affairs and Fisheries, 2018; Business Finland, Visit Finland, 2018.)

The water-based tourism sector employs over 25 000 people. The living resources sector employs merely 10% of the employment of the tourism sector, providing jobs for slightly under 2600 people. Turnover for the living resources sector was 916 million euros in 2017, creating a value added of roughly 154 million euros. The renewable energy sector is the smallest of the three, with a turnover of 321 million euros and 300 million euros in value added. The value-added ratio for the blue energy sector is the highest of the three sectors.

Tourism is the world's fastest growing business sector, and island- and water-based tourism is globally the most attractive segment of tourism. Finland is the world's largest freshwater country, and is among the top countries in Europe measured by the number of islands. Finland's lakes, archipelago, rivers, sea-, and coastal areas are important attractions for foreign-, and domestic tourists. (Island Committee; Onvision Consulting; Caprice Consulting, 2017.) The national tourism demand is estimated to be approximately 13 billion euros, and it is projected to grow to 20 billion euros by 2025. Furthermore, tourism's direct value added from the national GVA is measured to be 2.7%, and this share is expected to increase to 3% by 2025. The employment of the sector is expected to increase by 40 000 full-time jobs. (Elinkeino- ja innovaatio-osasto, 2015.)

The tourism sector has substantial multiplier effects on other industries such as the construction-, food-, trade-, financial services-, as well as the textile industry. (Elinkeino- ja innovaatio-osasto, 2015) In 2014, coastal areas comprised of 76% of the total tourism demand (Business Finland, Visit Finland, 2018). Tourism demand in this estimation consists of all the goods and services tourists buy, thus are not limited to the definition of

the blue economy, or blue tourism used in the analysis of this thesis. From the 13-billion-euro estimation, the blue economy share comes to approximately 39%. By productization and marketing, Finland could increase its water-based tourism demand and create new business and jobs for the economy. (Island Committee; Onvision Consulting; Caprice Consulting, 2017.)

The coastal and maritime tourism sector of Europe is one of the focus areas of the Blue Growth Strategy. Coastal tourism accounts for approximately 40% (70.4 billion) of the EU's blue economy GVA, and 61% (over 2 million people) of the blue economy employment. In Finland, the coastal tourism sector accounts for roughly 26% of the total turnover, 37% of the total employment, and 12% of the total GVA generated by the blue economy sector. (Directorate - General for Maritime Affairs and Fisheries, 2018.)

It is clear that leaving out the non-maritime and water-based tourism sectors has an effect on the results of the economic analysis of the tourism sector. Even though the blue tourism sector is not the largest blue economy sector based on the economic analysis done in this study, it is still an economically significant sector measured by employment and turnover, with high potential for growth, which is enforced by the current political ethos of Finland.

To compare, the renewable energy sector is the smallest of the blue economy sectors, but it has the best productivity ratio (see Table 20.), creating more value added per employment than any other blue economy sector. The blue energy sector’s share from the total output of the energy supply industry is roughly 3.6%, and slightly over 7% of the industry value added. Furthermore, the value added to turnover share of marine energy is twice of that of the energy supply industry (0.46).

The total turnover of Finnish blue energy in 2017 was over 300 million euros. The industry employed merely 239 FTE employees, and created added value roughly 300 million euros. The share of exports from the domestic energy production is minuscule, less than 13 000 euros.

Solutions for water-based energy are researched and developed due to the growing pressure of climate change and GHG-emission reduction goals. In Finland, hydropower is an important load following energy production method due to its certainty in production. Currently, the share of hydro power in electricity production is between 10-20% from the total electricity production of Finland.

In 2015 in Europe, the hydropower sector created approximately 38 billion euros in value added. This amount is estimated to grow to 75 to 90 billion by 2030. Furthermore, investments in the sector are projected to reach 180 billion euros by 2030. The hydropower sector creates over 100 000 jobs Europe-wide, and the average productivity of a full-time employee is eight times the average productivity of a worker in the European manufacturing industry. (Mennel, et al., 2015.)

As for marine-based energy, coastal- and offshore wind power are currently the most economically feasible technologies for the production of energy. In fact, in the next ten years, offshore wind power is expected to surpass the land-based wind power production and installation capacity. Off-shore wind power is not yet operated in large scale in Finland. However, the majority (81%) of the land-based wind power plants are located on the coastal areas of Finland (NUTS 3). (Sundelin & Putkonen, 2013).

Further there are many emerging technologies striving to harness the movement of waves or the tidal movements of oceans and seas. As the Baltic Sea is a shallow body of water, the tidal movement is not prominent enough for a cost-efficient utilization of the tidal energy. However, some studies suggest that wave power might, in small-scale units, be a potential technology for marine-based energy production in the near future. Even in sites where the average wave height is limited, wave power may be of economic interest if the utility factor for the installation is high enough. (Leijon, et al., 2003.) Wave- and tidal power is seen to have more potential in regions where the tidal conditions are better, and average wave heights are more sizeable. However, there are some technology companies based in Finland, that are further along the way in the development of wave power technologies. With research and development efforts, Finland could become a valid competitor of these emerging technologies in the global markets. (Leino, 2011.)

The living resources sector in Finland is relatively small compared to some other European member states. It is also one of the smallest blue economy sectors in Finland. Nearly 1800 companies are practicing actively in the living resources sector, although the majority of these companies are small-scale businesses. The industry employs roughly 2500 people, of which the fish processing industry provides 30%, retail sale of fish 23%, and wholesale of fish 19.6% of the jobs in the industry. In terms of turnover, the largest industry within the sector was the wholesale of fish, followed by fish processing and retail

sale of fish. In 2017, approximately 14.6 million kilos of fish was cultivated for human consumption; the industry grew slightly from the previous year.

As for Europe, the living resources sector accounts for 15% of blue economy jobs, 11% of the value added, and 9% of the profits in the blue economy sector. (Directorate - General for Maritime Affairs and Fisheries, 2018.) In the Finnish blue economy, the living resources sector covers roughly 4.7% of the sector's total employment, 3.9% of the combined value added, and 6% of the combined turnover. The role of the sector is thus slightly less prominent in Finland that it is on the European scale.

In Europe fishing is a significant sector measured by employment and economic activity, although it seems to concentrate in a handful of countries. The living resources sector employs over half a million full-time workers in Europe. The countries that account for the majority (73%) of jobs in the European fisheries are Spain, Greece, Italy, and Portugal. Aquaculture accounts for 20% of fish production in Europe and employs around 85 000 people. (European Commission, 2018.) Most of the sector's value added is generated by the wholesale industry, followed by fish processing and capture fisheries. The overall output of the living resources sector has remained relatively constant since the beginning of the 19th century, whereas the global trend of the sector has increased at a 7% annual rate. (Directorate - General for Maritime Affairs and Fisheries, 2018.)

The Finnish Government has raised fishing and aquaculture to an essential role in the Food 2030 policy report. Despite the plentiful water reserves Finland possesses, the majority of the fish consumed is imported cultivated fish. The living resources sector has nearly doubled in size in the past few decades, and the valuation and demand of consumers for fish products keeps on increasing.

Furthermore, aquaculture is projected to have significant potential in creating jobs and new business, as well as improving food autarchy in Finland. Most considerable growth potential for aquaculture is seen in the high seas and water recirculation facilities, although sustainable aquaculture technologies and expertise have substantial growth potential in national as well as global markets, thus aquaculture could become a significant industry in Finland and improve the balance of fish trade as well as the country’s dependence on imported fish. The number of fishing companies and fishers has however decreased; thus, the amount of fish caught in coastal areas and inland may diminish. The prerequisites for developing and growing the fishing industry are

nevertheless promising due to the increased profits in the fish processing and sale industries. (Valtioneuvosto, 2017.)

8. Conclusions

The importance of the marine ecosystems and their sustainable utilization and management is increasingly recognized in today's global political agenda. In order to regulate and manage these ecosystems cost-efficiently, an understanding of the blue economy sector's economic magnitude is crucial. Therefore, understanding the marine economy's economic weigh is essential for optimal policymaking.

The purpose of this study was to provide an understanding of the most common economic activities regarded as part of the blue economy sector, and calculate the sector's economic contribution within the Finnish national economy. This study is the first attempt to measure the economic contribution of the blue economy sector in Finland on this scale.

Based on a literature review, I identified 9 sectors and 55 economic activities as part of the blue economy to provide a valid basis for the estimation of the sector's economic contribution. For the case of Finland, this classification was slightly modified due to data limitations and structural attributes of the Finnish economy. For Finland, I defined six maritime sectors. These sectors include the living resources sector, the marine industry, the tourism-, public-, and the education and research and development sector.

I measured the economic contribution of these sectors by calculating economic indicators such as turnover, employment, value-added, and the share of exports. These indicators were then compared to national values of GDP, GVA, employment, and total output measured at current prices. Ratios of these macro-indicators are calculated for each blue economy sector, to provide insight on the productivity and performance of these sectors.

The six sectors of the Finnish blue economy generated in total a turnover between 14.6 and 20.2 billion euros, constituting roughly 3.5–4.9% of the total national output. The blue economy sector created 4 to 5.8 billion euros in value added, which accounts for over 2% of the national GVA, and 1.8–2.6% from the GDP. The sector employs somewhere between 53 000–71 000 people, which is 2–2.7% of the national employment of Finland. The share of exports from the national total is estimated to be between 4–6.2%, and 3.5 and 5.4 billion euros.

The largest blue economy sector in Finland, in terms of value added, is the marine construction sector followed by transportation, ports, and the public sector. Measured by turnover and employment, tourism is the largest blue economy sector. The marine construction- and transportation sectors are the most significant sectors measured by exports.

Further, as compared to other essential sectors of the Finnish national economy, the blue economy sector is slightly larger than forestry, and based on the high estimate of the sector, possibly even larger than the forest industry, covering 2.1–2.8% of the national gross value added. In terms of employment, the blue economy sector's proportion is slightly more than that of forestry and the forest industry, but less than that of agriculture. Forestry and the forest industry are commonly considered as significant producers of economic wellbeing in Finland, thus the blue economy sector should gain similar attention in political decision-making. Undeniably, the forest industry's share of the national exports is more significant than that of the blue economy sector, but the dynamicity of the marine industry and the industry's prospects in digitalization and automation should not be disregarded.

One of the weaknesses of this study relates to the lack of detailed statistical data, and therefore to the uncertainty regarding the accuracy of the maritime estimates. These challenges contribute to the ambiguity regarding the values derived with the maritime-ratios for the partially maritime industries. Further, the estimates calculated are based on values of turnover and output, and likely do not represent the correct estimates of employment as these macro-indicators do not necessarily exist in the same proportion. The results derived in the analysis do however present likely estimations regarding the relative contribution of blue economy on the national level, as the sensitivity analysis does not vary significantly in magnitude. Moreover, when compared to studies estimating the economic contribution of the blue economy sector in within the EU, the results and methods of this study seem to align.

Currently, measured by GVA, the role of the blue economy sector is quite prominent; however, the sector consists of many industries that have substantial multiplier effects for the national economy that have not been accounted for in this study. Future studies could be focused on finding and measuring other descriptive macro-indicators, such as those determining the dynamicity and innovativeness of the industries. Another need for future

study is the growth potential of these blue economy sectors, as it can be assumed that in the future the role of sustainable alternatives for food cultivation, energy production and transportation are needed.

References

ECOTEC Research & Consulting, 2006. *An exhaustive analysis of employment trends in all sectors related to sea or using sea resources ,* s.l.: European Commission.

Barbier, E. B., 2017. Marine ecosystem services. *Current Biology,* Volume 27, pp. R431-R510.

Barthwal, R.R., 2004: 519-522. Industrial Economics: An introduction Text Book, 2nd edition. New Delhi: New Age International Publishers.

Bollmann, M. et al., 2010. *World Ocean Review,* Hamburg: maribus gGmbH.

Burda, M. & Wyplosz, C., 2001:20-39. *Macro-economics, A European text.* 3rd Edition. Oxford: Oxford University Press

Business Finland, Visit Finland, 2018. *Matkailutilinpito - Matkailun talous- ja työllisyysvaikutukset 2015-2016,* Helsinki: Visit Finland.

Colgan, C., 2003. *Measurement of the Ocean and Coastal Economy: Theory and Methods, Maine, USA: National Ocean Economics Program. ,* Main, USA: National Ocean Economics Program (NOEP).

Commission of the European Communites, 2007. *An Integrated Maritime Policy for The European Union,* Brussels: European Union.

Commission of the European Communities, 2007. *An Integrated Maritime Policy for the European Union,* Brussels: Commission of the European Communities.

Directorate - General for Maritime Affairs and Fisheries, 2018. *The 2018 Annual Economic Report on EU Blue Economy,* s.l.: European Commission.

EASOS, 2014. *Study on the Establishment of a Framework for Processing and Analysing of Maritime Economic Data in Europe,* Luxembourg: European Commission.

Ecorys; Deltares; Oceanic Développement, 2012. *Blue Growth: Scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts,* Rotterdam/Brussels: European Commission, DG MARE.

ECORYS, 2013. *Study in support of policy measures for maritime and coastal tourism at EU-level,* Rotterdam/Brussels: The European Commission.

Elinkeino- ja innovaatio-osasto, 2015. *Matkailun tiekartta 2015-2025,* Helsinki: The Ministry of Employment and the Economy.

Energiateollisuus, 2018. *Energiantuotanto.* [Online]
Available at: https://energia.fi/perustietoa_energia-alasta/energiantuotanto/sahkontuotanto/vesivoima
[Accessed 23 November 2018].

EUNETMAR, 2013. *Methodology for indentifying and estimating MEAs using NACE and other data,* s.l.: European Commission.

EUNETMAR, et al., 2013. *Study on Blue Growth, Maritime Policy and the EU Strategy for the Baltic Sea Region,* s.l.: European Commission.

European Commission, 2012. *Blue Growth, Opportunities for marine and maritime sustainable growth,* Brussels: European Commission.

European Commission, 2013. *COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Strategic Guidelines for the sustainable development of EU aquaculture ,* s.l.: European Commission.

European Commission, 2017. *Blue Economy in the EU.* [Online]
Available at: https://publications.europa.eu/en/publication-detail/-/publication/030d66f1-5564-11e7-a5ca-01aa75ed71a1/language-en
[Accessed 14 5 2018].

European Commission, 2017. *Horizon 2020; Work programme 2018-2020; 9. Food security, sustainable agriculture and forestry, marine,,* s.l.: European Commission.

European Commission, 2017. *Report on the Blue Growth Strategy - Towards more sustainable growth and jobs in the blue economy,* Brussels: European Commission.

European Commission, 2018. *Facts and figures on the common fisheries policy - Basic statistical data, 2018 edition.* Luxemburg: Publications Office of the European Union.

EUROSTAT, 1995-2018. *RAMON - Reference And Management Of Nomenclatures.* [Online]
Available at:
http://ec.europa.eu/eurostat/ramon/relations/index.cfm?TargetUrl=LST_REL&StrLanguageCode=EN&IntCurrentPage=10
[Accessed 8 August 2018].

Finanssiala Ry, 2018. *Finanssiala 2017 - Vakuutusyhtiöiden tuloskatsaus,* s.l.: Finanssiala Ry.

Foley, N. et al., 2014. Developing a Comparative Marine Socio-Economic Framework for the European Atlantic Area. *Journal of Ocean and Coastal Economics,* 2014(1), p. Article 3.

HELCOM, 2018. *HELCOM Assessment on maritime activities in the Baltic Sea 2018,* s.l.: Helsinki Commission.

Hyötytuuli, 2018. *Hyötytuuli.* [Online]
Available at: https://hyotytuuli.fi/merituulivoima
[Accessed 23 October 2018].

Island Committee; Onvision Consulting; Caprice Consulting, 2017. *Making island and water-based tourism in Finland into a European attraction, Final report of the Survey of Island and Water-based tourism,* Helsinki: Ministry of Agriculture and Forestry.

Itämeri- ja meripolitiikan ohjausryhmä, 2018. *Meripolitiikan linjaukset,* Helsinki: Valtionneuvoston kanslia.

Jääskeläinen, M; Rantala, L; Sundelin, A, 2012. *Merituulipuiston rakentaminen,* s.l.: Prizztech oy.

Kalaydijan, R. et al., 2009. *French marine economic data 2009,* Brest, France: Ifremer – Centre of Brest.

Karvonen, T., 2018. Personal communication via email on 9th of March, 2018.

Karvonen, T. et al., 2016. *Suomen meriklusteri kohti 2020-lukua,* s.l.: The Ministry of Economic Affairs and Employment of Finland.

Leijon, M., Bernhoff, H., Berg, M. & Ågren, O., 2003. Economical considerations of renewable electric energy production - especially development of wave energy. *Renewable Energy,* July, 28(8), pp. 1201-1209.

Leino, R., 2011. Tässäkö energiantuotannon tulevaisuus? Aaltovoiman tekniikat esittelyssä. *Tekniikka ja talous*, 14 October.

Martínez, M. et al., 2007. The coasts of our world: Ecological, economic and social importance. *Ecological Economics,* Volume 63, pp. 254-272.

Mendler de Suarez, J. et al., 2014. Ensuring survival: Oceans, climate and security. *Ocean & Coastal Management,* Volume 90, pp. 27-37.

Mennel, T. et al., 2015. *The hydropower sector's contribution to a sustainable and prosperous Europe,* s.l.: A European Hydropower Initiative of hydropower Companies and Associations.

Meriteollisuus ry, 2018. *Meriteollisuus (Finnish Marine Industries).* [Online]
Available at: https://meriteollisuus.teknologiateollisuus.fi/meriteollisuus-ry/suomen-meriteollisuus
[Accessed 16 October 2018].

Ministry of Economic Affairs and Employment of Finland, 2015. *Yhdessä enemmän - kasvua ja uudistumista Suomen matkailuun,* s.l.: Ministry of Economic Affairs and Employment of Finland.

Nyroos, S. & Yliskylä-Peuralahti, J., 2017. *Suomen meripolitiikan kehittämisseminaari,* Turku: The Prime Minister's Office Finland.

Park, K. S., 2014. *A study on rebuilding the classification system of the Ocean Economy ,* Monterey: Monterey: Center for the Blue Economy in Monterey Insitute of International Studies.

Pelastusopisto, 2017. *Pelastustoimien taskutilasto,* s.l.: Pelastusopisto.

Pendelton, L., Solgaard, A. & Siegel, P., 2012. *Green Economy in a Blue World,* s.l.: UNEP; FAO; IMO; UNDP; IUCN; WorldFish Center; Grid-Arendal.

Pohjola, M., 2017 :132-133,147-150. Taloustieteen oppikirja. Helsinki: SanomaPro Oy.

Pohjola, T. & de Andres Gonzalez, O., 2018. *Report on the current status of blue economy business sectors and development trends of key sectors,* s.l.: SYKE.

Prime Minister's Office Publications , 2017. *Finland's Strategy for the Baltic Sea Region,* s.l.: Prime Minister's Office Publications .

Prizztech, 2016. *Finnish Offshore Industry 2016-2017,* s.l.: Ministry of Economic Affairs and Employment of Finland; Finnish Marine Industries; Prizztech.

Prosser, L., 2007. *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007),* s.l.: Office for National Statistics.

Pugh, D. & Skinner, L., 2002. *A new analysis of marine-related activities in the UK economy,* Southhampton: www.marine.gov.uk.

Puolustusvoimat, Pääesikunnan viestintäosasto, n.d. *Joukko-osastot.* [Online]
Available at: https://merivoimat.fi/joukko-osastot
[Accessed 18 November 2018].

Roberts, J. & Ali, A., 2016. *The Blue Economy and Small States,* London: Commonwealth Secretariat.

Räisänen, N., 2018. *Uutiset / Suomen puolustusbudjetti kasvanee merivoimien uusien alusten myötä.* [Online]
Available at: https://ruotuvaki.fi/uutinen/-/asset_publisher/suomen-puolustusbudjetti-kasvanee-merivoimien-uusien-alusten-myota
[Accessed 18 November 2018].

Salvador, R., Simões, A. & Soares, C., 2015. *Features of the European Maritime Clusters, 55th Congress of the European Regional Science Association:"World Renaissance: Changing roles for people and places".* Lisbon, ECONSTOR;European Regional Science Association.

Seutukaupunkiverkosto (T50), 2018. *Meriteollisuuden tietopaketti,* s.l.: SEUTU kaupungit, Etelä-Pohjanmaan liitto, SEK.

Sundelin, A. & Putkonen, J., 2013. *Strateginen selvitys Suomen merituulivoimaliiketoiminnan kehittämiseksi,* s.l.: Prizztech oy.

Suomen virallinen tilasto (SVT), 2018. *Fishery and game statistics, Profitability of fishery.* [Online] Helsinki: Tilastokeskus [Accessed: 5 November 2018].
Available at:
http://statdb.luke.fi/PXWeb/pxweb/en/LUKE/LUKE__06%20Kala%20ja%20riista__04%20Talous__06%20Kalatalouden%20kannattavuus/?tablelist=true&rxid=001bc7da-70f4-47c4-a6c2-c9100d8b50db

Suomen virallinen tilasto (SVT), 2014. *Julkisen sektorin ympäristönsuojelumenot kasvoivat* [verkkojulkaisu]. ISSN=2323-1572. 2012. Available at: http://www.stat.fi/til/jsys/2012/jsys_2012_2014-04-08_tie_001_fi.html
Helsinki: Tilastokeskus [Accessed 29 January 2019]
Suomen virallinen tilasto (SVT), 2018. *Kansantalouden tilinpito - Julkisyhteisöjen menot tehtävittäin, Taulukko 1.* Helsinki: tilastokeskus

Suomen virallinen tilasto (SVT), 2018. *Kansantalouden tilinpito - Käyttötaulukko perushintaan 2010-2014 Muuttujina vuosi, tuote, toimiala.* [Online] Available at: http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__kan__pt/statfin_pt_pxt_002.px/?rxid=575ac696-7695-48d5-a8bd-082e6bd6c82b
Helsinki: Tilastokeskus [Accessed 29 January 2019]

Suomen virallinen tilasto (SVT): *Kansantalouden tilinpito. Käsitteet ja määritelmät.* [verkkojulkaisu].
ISSN=1795-8881. Helsinki: Tilastokeskus [Accessed: 29.1.2019].
Available at: http://www.stat.fi/til/vtp/kas.html

Suomen virallinen tilasto (SVT), 2018. *Kansantalouden tilinpito National Accounts 2008-2017** [Online] Available at: https://www.stat.fi/til/vtp/vtp_2017_2018-07-12_tau_fi.pdf
Helsinki:Tilastokeskus [Accessed 29 January 2019]

Suomen virallinen tilasto (SVT), 2018. *Kansantalouden tilinpito: Taulukko 007 & 008.* Helsinki: Tilastokeskus

Suomen virallinen tilasto (SVT), 2015. *Kaupallinen kalastus sisävesillä 2014.* [Online]
Available at: https://stat.luke.fi/kaupallinen-kalastus-sis%C3%A4vesill%C3%A4-2014_fi
[Accessed 5 October 2018].

Suomen virallinen tilasto (SVT), 2018. *Kalajalosteiden tuotanto 2017.* [Online]
Available at: stat.luke.fi/kalajalosteiden-tuotanto-2017_fi
[Accessed 5 November 2018].

Suomen virallinen tilasto (SVT), 2018. *Kaupallinen kalastus merellä.* [Online]
Available at: stat.luke.fi/kaupallinen-kalastus-merellä
[Accessed 5 November 2018].

Suomen virallinen tilasto (SVT), 2018. *Koulutus, Oppilaitosten opiskelijat ja tutkinnot 2010-2014, Taulukko 002.* Helsinki: Tilastokeskus

Suomen virallinen tilasto (SVT), 2018. *Matkailutilinpito.* Helsinki: Tilastokeskus

Suomen virallinen tilasto (SVT): *Sähkön ja lämmön tuotanto* [online].
ISSN=1798-5072. 2016. Helsinki: Tilastokeskus [Accessed: 30.1.2019].
Available at: http://www.stat.fi/til/salatuo/2016/salatuo_2016_2017-11-02_tie_001_fi.html?ad=notify

Suomen virallinen tilasto (SVT), 2018. *Tilastotietokannat StatFin, Yritykset toimialoittain 2013-2017.* [Online]
Available at:

http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__yri__yrti/statfin_yrti_pxt_002.px/?rxid=4fc9f8d8-15ff-4b1a-ab87-1ca283dcd73b
[Accessed 5 November 2018].

Suomen virallinen tilasto (SVT), 2018. *Vesiviljely 2017.* [Online]
Available at: stat.luke.fi/vesiviljely-2017_fi
[Accessed 5 November 2018].

Surís-Regueiro, J., Garza-Gil, D. & Varela-Lafuente, M., 2013. Marine Economy: A proposal for its definition in the European Union. *Marine Policy,* Volume 42, pp. 111-124.

The Ministry of Forestry and Agriculture, 2016. *Growth through water expertise and sustainable use of aquatic natural resources: National Development Plan for Blue Bioeconomy 2025,* s.l.: The Ministry of Agriculture and Forestry.

United Nations, 2014. *Blue Economy Concept Paper,* s.l.: The United Nations.

Valtioneuvosto, 2017. *Ruoka2030 - Valtioneuvoston selonteko ruokapolitiikasta,* s.l.: The Ministry of Agriculture and Forestry.

Vega, A., Corless, R. & Hynes, S., 2013. *Ireland's Ocean Economy.* ISSN 2009-6933 (online) ed. s.l.:NUI Galway, ISSN.

Visbeck, M. et al., 2014. Securing blue wealth: The need for a special sustainable development goal for the ocean and coasts. *Marine Policy,* Volume 48, pp. 184-191.

Appendix

Maritime economic activities found in literature

Table A1. Maritime economic activities found in literature

MEA		Eunet-mar (2013)	Easos (2014)	Ecotec (2006)	Maritime Affairs & Fisheries (2018)	Foley et al. (2014)	Innova-mar (2011)	Kalaydi-jan (2014)	Pohjola et al. (2018)	Pugh (2002)	Surís-Reguiero (2013)	Vega et al. (2013)
Marine fishing	**0311**	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Freshwater fishing	**0312**	✓						✓		✓		
Marine aquaculture	**0321**	✓	✓		✓	✓	✓		✓		✓	✓
Extraxtion of crude petroleum	**0610**	✓	✓	✓	✓	✓			✓	✓	✓	✓
Extraction of natural gas	**0620**	✓	✓	✓	✓	✓			✓	✓	✓	✓
Operation of gravel and sand pits	**0812**	✓	✓	✓		✓		✓		✓	✓	✓
Extraction of salt	**0893**		✓			✓					✓	✓
Support activities for petrolium and natural gas extraction	**0910**	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Support services for mining and quarrying	**0990**	✓	✓	✓		✓					✓	✓
Processign and preserving of fish	**1020**	✓	✓		✓	✓	✓	✓		✓	✓	✓
Prepared meals	**1085**		✓				✓				✓	
Manufacture of engines and turbines	**2811**		✓	✓			✓				✓	
Building of ships and floating structures	**3011**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Building of pleasure and sporting boats	**3012**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Repair and maintenance of ships and boats	**3315**	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Production of electricity	**3511**		✓			✓		✓	✓	✓	✓	✓
Transmission services of electricity	**3512**		✓			✓			✓			✓
Water treatment and supply services	**3600**	✓	✓								✓	
Dismantling of wrecks	**3831**		✓			✓					✓	✓
Remediation activities and other waste	**3900**		✓								✓	✓

management services													
Construction of utility projects for fluids	**4221**					✓	✓				✓	✓	
Construction of water projects	**4291**	✓	✓	✓	✓	✓		✓		✓	✓	✓	
Other specialized construction projects	**4399**					✓					✓	✓	
Agents involved in the sale of machinery, industrial equipment and ships and aircraft	**4614**			✓			✓				✓		
Wholesale of food including fish etc.	**4638**	✓			✓			✓			✓	✓	
Retail sale of fish, crustaceans, molluscs	**4723**	✓			✓	✓					✓	✓	
Sea & coastal passenger water transport	**5010**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Sea & coastal freight water transport	**5020**	✓	✓	✓	✓	✓		✓	✓	✓	✓		
Inland passenger water transport	**5030**		✓		✓	✓		✓				✓	
Inland freight water transport	**5040**	✓	✓		✓	✓		✓				✓	
Warehousing and storage	**5210**	✓	✓	✓	✓		✓				✓		
Service activities incidental to water transportation	**5222**	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Cargo handling	**5224**	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Other transportation support services	**5229**		✓	✓			✓	✓			✓	✓	
Hotels and similar accommodation	**5510**	✓			✓	✓			✓		✓	✓	
Holida and short-stay accommodation	**5520**	✓			✓	✓			✓		✓	✓	
Camping grounds, recreational vehicle parks and trailer parks	**5530**	✓			✓	✓			✓		✓	✓	
Other accommodation	**5590**	✓			✓				✓		✓		
Restaurants and mobile food services	**5610**				✓	✓			✓		✓	✓	
Beverage serving activities	**5630**				✓	✓			✓		✓	✓	
Non-life insurance	**6512**		✓	✓		✓	✓				✓	✓	

Insurance, re-insurance and pension funding	**6520**		✓	✓		✓		✓		✓	✓	
Architectural activities	**7111**					✓	✓					✓
Engineering activities and related technical consultancy	**7112**					✓		✓			✓	✓
Research and development	**7200**			✓		✓	✓			✓	✓	
Research and development of biotechnology	**7211**		✓	✓			✓					
Other professional, scientific and technical activities	**7490**			✓			✓	✓		✓		
Renting and leasing of recreational and sports goods	**7721**					✓	✓			✓	✓	✓
Rental & leasing services of water transport equipment	**7734**	✓	✓		✓	✓	✓		✓	✓	✓	✓
Travel agency activities	**7911**			✓					✓	✓	✓	
Tour operator activities	**7912**								✓	✓	✓	
General public administration activities	**8411**		✓					✓			✓	
Regulation of and contribution to more efficient operation of businesses	**8413**							✓			✓	✓
Defense activities	**8422**		✓	✓		✓		✓		✓	✓	✓
Public order and safety activities	**8424**		✓			✓				✓	✓	✓
Technical and vocational secondary education	**8532**					✓					✓	✓
Higher education	**8540**			✓				✓		✓		
Non-tertiary education	**8542**					✓					✓	✓
Sports and recreation education	**8551**					✓					✓	✓
Activities of sports clubs	**9312**					✓					✓	✓
Other amusement and recreation activities	**9329**		✓						✓	✓	✓	✓
MEA	NACE	Eunet-mar (2013)	Easos (2014)	Ecotec (2006)	Maritime Affairs & Fisheries (2018)	Foley et al. (2014)	Innova-mar (2011)	Kalaydi-jan (2014)	Pohjola et al. (2018)	Pugh (2002)	Surís-Reguiero (2013)	Vega et al. (2013)

List of economic activities

Table A2. List of economic activities - Literature review

Economic activity	NACE	Sector
Marine fishing	**A.03.11**	Living resources
Freshwater fishing	**A.03.12**	
Marine aquaculture	**A.03.21**	
Processing and preserving of fish, crustaceans and molluscs	**C.10.20**	
Prepared meals and dishes	**C.10.85**	
Retail sale of fish, crustaceans and molluscs in specialized stores	**G.47.23**	
Wholesale of other food, including fish, crustaceans and molluscs	**G.46.38**	
Extraction of crude petroleum	**B.06.10**	Non-living resources
Extraction of natural gas	**B.06.20**	
Support activities for petroleum and natural gas extraction	**B.09.10**	
Operation of gravel and sand pits; mining of clays and kaolin	**B.08.12**	
Support services for other mining and quarrying	**B.09.90**	
Extraction of salt	**B.08.93**	
Agents involved in the sale of machinery, industrial equipment, ships and aircraft	**G.46.14**	
Sea and coastal passenger water transport	**H.50.10**	Transportation
Sea and coastal freight water transport	**H.50.20**	
Inland passenger water transport	**H.50.30**	
Inland freight water transport	**H.50.40**	
Other transportation support activities	**H.52.29**	
Non-life insurance	**K.65.12**	
Reinsurance	**K.65.20**	
Rental and leasing services of water transport equipment	**N.77.34**	
Cargo handling	**H.52.24**	Ports
Construction of utility projects for fluids	**F.42.21**	
Construction of water projects	**F.42.91**	
Other specialised construction activities	**F.43.99**	
Service activities incidental to water transportation	**H.52.22**	

Warehousing and storage services	**H.52.10**	
Building of ships and floating structures	**C.30.11**	Shipbuilding
Building of pleasure and sporting boats	**C.30.12**	
Repair and maintenance of ships and boats	**C.33.15**	
Dismantling of wrecks	**E.38.31**	
Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	**C.28.11**	Manufacture
Production of electricity	**D.35.11**	
Transmission services of electricity	**D.35.12**	
Hotels and similar accommodation	**I.55.10**	Tourism
Holiday and other short stay accommodation	**I.55.20**	
Camping grounds, recreational vehicle parks and trailer parks	**I.55.30**	
Other accommodation	**I.55.90**	
Restaurants and mobile food service activities	**I.56.10**	
Beverage serving activities	**I.56.30**	
Renting and leasing of recreational and sports goods	**N 77.21**	
Travel agency activities	**N.79.11**	
Tour operator activities	**N.79.12**	
Activities of sports clubs	**R.93.12**	
Other amusement and recreation activities	**R 93.29**	
Natural water; water treatment and supply services	**E.36.00**	Public sector
Remediation activities and other waste management services	**E.39.00**	
Public administration and defense; compulsory social security	**0.84.00**	
Education	**P.85.00**	Education, R&D
Architectural activities	**M.71.11**	
Engineering activities and related technical consultancy	**M 71.12**	
Research and (experimental) development of biotechnology	**M.72.11**	
Research and development	**M.72.00**	
Other professional, scientific and technical activities n.e.c. (Environment)	**M.74.90**	

Maritime shares - Marine construction

Table A3. Marine-based macro-indicator shares of MEAs - Marine Construction

CONSTRUCTION		Maritime share of MEAs from the total industry values									
		Marititime share:		Turnover €		Employment		Value added €		Export €	
NACE, MEA			Prizztech, 2016		Prizztech, 2016	MI Share (i-o)	Prizztech, 2016		Prizztech, 2016		Prizztech, 2016
24	Manufacture of basic metals	0,0233	0,02	298423028	256027080	290,861742	249,54	3E+07	3E+07	1,33E+08	113938560
25	Manufacture of fabricated metal products, except machinery and	0,0186	0,18	137364322	1330284600	685,105128	6634,8	4,4E+07	4E+08	29195478	282739320
26	Manufacture of computer, electronic and optical products	0,0058	0,09	78854096,1	1233212040	109,66316	1715,04	2,4E+07	4E+08	19996044	312721380
27	Manufacture of electrical equipment	0,0085	0,09	46341555,2	492705000	130,733214	1389,96	1,5E+07	2E+08	35673754	379284570
28	Manufacture of machinery and equipment	0,0115	0,09	1910299399	1491253290	510,665133	3986,46	5E+07	4E+08	89781615	700871850
29	Manufacture of motor vehicles, trailers and semi-trailers	0,0153	0,09	30770769,2	1807070040	125,298731	735,84	6911659	4E+07	22505037	132165000
301	Building of ships, boats and floating	1 (0,84)	1	1743312000	1743312000	5258	5258	3,6E+08	4E+08	1,07E+09	1068438000
3315	Repair and maintenance services of ships and boats	1 (0,05)		133296000	133296000	639	639	6,6E+07	7E+07	10544700	10544700
4291	Construction of water projects	1 (0,04)	1	112613000	112613000	439	439	4,4E+08	4E+08	0	0
62	Computer programming, consultancy and related activities & 63 Information	0,011	0,05	111064655	112613000	560,659872	2550,45	6E+07	3E+08	66086344	300627750
70	Activities of head offices; management consultancy activities	0,0085	0,05	25910780,8	505234750	140,180486	822,45	2,6E+07	2E+08	12008002	70451900
71	Architectural and engineering activities; technical testing and	0,033	0,05	191975869	290651650	1380,18407	2089,6	5,3E+07	8E+07	20605139	31196200
74	Other professional, scientific and	0,004	0,05	4645167,6	57867450	32,8154172	408,8	2504503	3E+07	28,09539	350
Total				**3105600642**	**7979184500**	**10302,1669**	**26918,94**	**1,2E+09**	**3E+09**	**1,51E+09**	**3402979580**
€ M, persons				**3105,6**	**7979,18**	**10265,00**	**26919,00**	**1182,54**	**2832,27**	**1507,64**	**3402,98**

Data

Data regarding the turnover and employment of the MEAs were derived directly from the structural business statistics data (SBS), compiled by the Official Statistics of Finland. Only in the case of the public-, education-, and research and development sectors, data used was derived from the official statistics regarding public expenditure as well as national education data.

For the most part, the latest available SBS-data was available for 2017, whereas the latest available public expenditure data was from year 2015. (Yritykset toimialoittain (SVT), 2018; Julkisyhteisöjen menot tehtävittäin (SVT), 2018.) National education data, used to determine the share of higher education, is also from year 2017. (Oppilaitosten opiskelijat ja tutkinnot (SVT), 2018.) Additionally, data used to calculate approximates for the maritime shares, as well as shares of value added and exports, were derived from the national accounts supply and usage-, and input-output -tables, which are updated every four years. The latest data available at the time was for year 2014. Data is sought at NACE four- and five-digit levels, however for some industries data at this level of detail was not available. (Kansantalouden tilinpito, Taulukko 001 & 002, 2018.)

Financial aggregate data concerning the marine industry and -cluster, was used to supplement the data found from the official statistics. This data is made available in various industry reports. Data extracted from the reports is from years 2014 and 2015; however, this data is only used for the maritime share estimations, therefore data regarding the marine sector and the macro-indicators presented, are for the most part from 2017. (Karvonen et al., 2016; Prizztech, 2016.)

Data regarding the living-resources sector was readily available in the database of official statistics of Finland, compiled by the Natural Resource Institute of Finland. The latest available data regarding value added and exports of this sector was from 2016. (Fishery and game statistics (SVT), 2018.) Furthermore, data on turnover and employment were derived from the structural business statistics, available for year 2017. (Yritykset toimialoittain (SVT), 2018.)

The share of the blue tourism sector, as defined in this study, is calculated by using an official, regional statistics database, Rudolf, compiled by Visit Finland. This database allows for the segregation of the industry's data by region at NUTS-3-level. The latest

available data regarding the tourism sector, was from 2015. However, data from 2015 was only used to estimate the coastal shares of the economic activities, and SBS data from year 2017 was used to determine the macro-indicators of the sector. (Matkailutilinpito (SVT), 2018.)

The public-, education-, and research and development sector, are industries that are not statistically compiled in the same way as the previous sectors. As for the water treatment, -supply, and sewerage services, data could be collected from the SBS data, and is from year 2017. However, financial data regarding the public sector and the education sector is not available in such form. For these sectors, statistical data compiling information on public expenditure were used. The public expenditure data is from 2016, except in the case of public expenditure data used to calculate estimates for the environmental protection sector, which are from year 2012. (Julkisyhteisöjen menot tehtävittäin (SVT), 2018; Oppilaitosten opiskelijat ja tutkinnot (SVT), 2018).

There is no NACE-code for the environmental protection activities that is currently in use, but some data can be found in the "environment and natural resources" database of Statistics Finland. The value added and export values of the public-, and the education sector, are derived from the annual national accounts, as well as the input-output tables of the National Accounts. (Kansantalouden tilinpito, Taulukko 001 & 002, 2018.)

Sensitivity analysis results

Here the results of all three-level estimates of the individual sectors are presented and evaluated. The medium estimates are presented in the economic analysis in section 5. and 6. due to their likeliness regarding the expected, realized economic contribution.

The highest estimate for the marine industry brings the combined turnover for the industry to approximately 8.6 billion euros, employment to 27 347 people, value added to roughly three billion euros, and the share of exports to 2.9 billion euros. The estimates calculated in this study fall behind the approximations of the marine industry by Karvonen et al. (2016), who report a turnover of 7.8 billion and employment of more than 28 000 persons. The 7.8-billion-euro estimate does not take in to account the ports-, transportation-, or other supporting operations sectors, which are included in the calculations presented here.

The macro-indicators calculated with the maritime shares reported in the Finnish Offshore Industry report (Prizztech, 2016), come closer to the assessment of Karvonen et al. (2016) and the Marine Industry's registered association (Meriteollisuus ry, 2018), who report the turnover of the entire marine industry to be roughly 13 billion euros.

Table A4. Macro-indicators for the Marine industry sectors, based on low, medium, high, and Prizztech (2016) estimates.
(Monetary values in billions of euros; employment in full time equivalents)

Low estimate	Turnover	Employment	Value added	Exports
Ports	1,62	5945	0,55	0,08
Transportation	2,53	7387	0,74	1,31
Marine construction	3,11	10265	1,18	1,51
Energy	0,32	239	0,30	0,01
Insurance	0,07	386	0,04	0,0021
Other	0,23	563	0,03	0,0014
Total, billions of euros	**7,87**	**24785**	**2,83**	**2,91**

Medium estimate	Turnover	Employment	Value added	Exports
Ports	1,98	7141	0,67	0,09
Transportation	2,53	7387	0,74	1,31
Marine construction	3,11	10265	1,18	1,51
Energy	0,32	239	0,30	0,01
Insurance	0,0739	471	0,05	0,00
Other	0,23	563	0,03	0,0014
Total, billions of euros	**8,23**	**26066**	**2,96**	**2,93**

High estimate	Turnover	Employment	Value added	Exports
Ports	2,34	8337	0,79	0,11
Transportation	2,53	7387	0,74	1,31
Marine construction	3,11	10265	1,18	1,51
Energy	0,32	239	0,30	0,01
Insurance	0,0753	556	0,05	0,00
Other	0,23	563	0,03	0,0014
Total, billions of euros	**8,60**	**27347**	**3,09**	**2,95**

Pritzztech & medium estimates	Turnover	Employment	Value added	Exports
Ports	1,979	7141	0,667	0,094
Transportation	2,53	7387	0,74	1,31
Marine construction	7,9791845	26919	2,83227	3,40297958
Energy	0,321	239	0,3	0,0126
Insurance	0,0739	471	0,047	0,002102
Other	0,23	563	0,03	0,0014
Total, billions of euros	**13,1047845**	**42720**	**4,61046**	**4,82411558**

The shares reported by Prizztech (2016) were only used on the marine construction sector, other than that, the calculation methods applied were the same as in the rest of the non-living resources sectors. The combined turnover with the low estimate and the Prizztech's

maritime shares comes to €13.1 billion euros and employment to 42 720 persons. The turnover value derived with this estimation indicates that the shares of the maritime operations are more substantial in the industry report by Karvonen et al., (2016) and the value chain approach is more accurately implemented.

The estimates for the insurance sector do not differ significantly, thus the maritime share of income from insurance payments, can be somewhere between 73.4 million euros and 75.3 million euros. The estimated employment of the sector is somewhere between 386 and 556 persons. The value added is assessed to range between 41.2 and 53.2 euros; whereas the share of export can lie between 2.09 and 2.14 million euros. It should be noted, that using income values instead of turnover values, lowers the total turnover of the Marine industry slightly.

Table A5. Macro-indicators for the Energy, Insurance, and Trade sector

		Employment (FTE)	**Turnover** (€, M)	**Value added** (€, M)	**Exports** (€, M)
Insurance					
Low estimate	total:	386	73,36	41,17	2,09
Medium estimate	total:	471	73,92	47,05	2,1
High estimate	total:	556	75,29	53,18	2,14

Based on the evaluations regarding the current employment and funding of the Finnish Navy, the highest estimate (Table A6.) is most likely the closest approximation of the current situation, and might even slightly under-estimate the size of the defense- and public order and safety industry's maritime proportion.

Due to the lack of detailed data, only information regarding the public expenditure on environmental protection could be derived. In year 2012, the share of water-based environmental protection was roughly 50% of all environmental expenses, thus the share of blue environmental protection is estimated to be somewhere between 400 and 500 million euros.

Table A6. Macro-indicators for the Public sector

Public sector					
NACE	**MEA**	**Turnover/ Public expenditure** (€, Million)	**Employment** (FTE)	**Value added** (€, Million)	**Export** (€, Million)
E 36.00	Natural water; water treatment and supply services	1018,48	2606	396	42,547

E 37.00	Sewerage	174,177	565	116,776	27,598
G02	Defence activities	120,805	1150	0,3289	0,086050
		265,771	1391,5	0,7236	0,189310
		434,898	1656	1,184112	0,309780
(year 2016) G03	Public order and safety activities	169,127	1127	460488	0,120470
		362,415	1380	986760	0,258150
		579,864	1656	1578816	0,413040
(year 2015)	Environmental protection	441,450	-	-	-
		490,500	-	-	-
		539,550	-	-	-
Total (low estimate)		1924,042	5448	513,5654	70,3518
		1924,04	**5448**	**513,57**	**70,35**
Total (medium estimate)		2311,346	5942,5	514,4864	70,5928
		2311,35	**5943**	**514,49**	**70,59**
Total (high estimate)		2746,972	6483	515,5389	70,8681
		2746,97	**6483**	**515,54**	**70,87**

According to a study on employment trends in marine education and research sectors, the sector employed at the time, approximately 1657 persons. (ECOTEC Research & Consulting, 2006.) Therefore, the values presented here could be valid approximations, noted that the water treatment and supply, and sewerage industries are additionally included in this analysis.

Table A7. Macro-indicators for the education and R&D sector

Education, R&D					
Nace	**MEA**	**Turnover/ Output** (€, Million)	**Employment**	**Value added** (€, Million)	**Exports** (€, Million)
M.72.00	Research and development	8,802	44,02	16,060	4,939
		22,005	110,05	40,150	12,348
		39,609	198,09	72,270	22,226
P.85.40	Higher education	63,684	732,6	46,134	0,052
		185,533	2134,308	134,404	0,152
		339,648	3907,2	246,048	0,278
Total	low estimate	72,486	776,62	62,194	4,991
		72,49	**777**	**62,19**	**4,99**
Total	Medium estimate	207,538	2244,358	174,554	12,499
		207,54	**2244**	**174,55**	**12,5**
Total	high estimate	379,257	4105,29	318,318	22,504
		379,26	**4105**	**318,32**	**22,5**